Suggestions to Authors of the Reports of the United States Geological Survey

Fifth Edition

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Thomas B. Nolan, *Director*

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FOREWORD

The responsibility of the United States Geological Survey does not end with the completion of its field or laboratory investigations, whether these have been carried on independently by the Geological Survey or cooperatively with other organizations. The knowledge acquired in such studies of the geology and of the mineral and water resources of the United States is made available to the public through the preparation and publication of suitable maps and reports.

The authors and all others responsible for the large aggregate output of reports during the nearly 80 years since the Survey was founded merit high tribute for their initiative, resourcefulness, integrity, masterful skill, and loyal devotion to duty in making a notable contribution to knowledge and to the welfare and security of the United States and its people. From the early days of the Geological Survey the authors of its publications have set up standards of soundness and effective, clear presentation—objectives whose attainment has been sought constantly through the years. Three fundamental requirements in the preparation and processing of a report are: (a) the manuscript report, as written and submitted by its author, should be creditable and well prepared; (b) it should receive careful and adequate scientific and editorial scrutiny; and (c) it must conform, as determined by administrative review, to policies and practices of the Survey.

Many Geological Survey manuals on the preparation of reports have aided greatly the authors, reviewers, illustrators, and editors for more than 60 years. The first manual was printed in 1888, and among the others to follow were four editions of "Suggestions to Authors." This fifth edition is longer and covers a considerably broader field than its predecessors. One unfortunate result of this more comprehensive treatment has been such an increase in the number of contributors that it has been undesirable to credit any single individual, or small group, as the listed author or authors. But I feel impelled to record here our gratitude and appreciation to two of those who were particularly responsible for the production of this edition. One of these individuals is Hugh D. Miser who, as chairman of the committee responsible for the planning and preparation of the volume, has rightly regarded it as an appropriate monument to his interest in scientific reports during 50 years of service with the Geological

Survey; the other is John C. Rabbitt, whose tragic and sudden death on June 10, 1957, occurred just as he was completing his final review on behalf of the Geologic Division of the Survey.

I commend this fifth edition to the authors and to all others involved in the publication program of the Survey, for their careful attention and use.

Thomas B. Nolan

Director

PREFACE

This edition of "Suggestions to Authors" is the latest of a long line of manuals designed to aid the Geological Survey's authors in the preparation of manuscript reports. An annotated chronological list of these manuals follows:

1. "Rules for the Preparation of Manuscript and Illustrations Designed for Publication by the United States Geological Survey," by Thomas Hampson, chief, Editorial Division, 1888.

Hampson's work is a pamphlet of 24 pages, 4 of them blank for insertion of additions. It was prepared, says Hampson in his transmittal letter to Director J. W. Powell, in accordance with his duty, as stated by Powell, "To secure clear and accurate statement in the material sent to press, careful proof-reading, and uniformity in the details of book-making, as well as to assist the Director in exercising a general supervision over the publications of the Survey * * *."

Thirty-eight rules are presented. Hampson says, "Throughout the work I have endeavored to bear in mind the desirability of satisfying the individual preferences of writers, and have sought to control these only so far as seemed to be necessary to secure clearness, consistency, and uniformity in the publications of the Survey."

2. "Suggestions for the Preparation of Manuscript and Illustrations for Publication by the U. S. Geological Survey," by W. A. Croffut, in charge, Editorial Division, 1892.

Croffut's 15-page pamphlet, prepared in the same format and printed and distributed in the same way as its predecessor, is a revision of the earlier one. The 38 "rules" of the first one have become 51 "suggestions." Concerning this change, Croffut's letter of transmittal says, "It is perhaps sufficient to put forth the results of this revision under the head of 'suggestions' rather than 'rules,' for experienced authors have definite literary preferences of their own, and you [Director Powell] have expressed the desire that they shall not be asked to surrender even the most trivial of these except to satisfy the claims of consistency."

3. "Suggestions to Authors of Geologic Folios," by C. W. Hayes geologist in charge, Geology, 1904.

This is a pamphlet of 8 pages. In a prefatory note addressed to authors, Hayes says, "Folios hereafter submitted will be expected to conform as nearly as possible to the plan outlined in the accompanying

suggestions. You are urged to give this plan careful study in connection with the preparation of folios on which you may be engaged. A close observance of the suggestions will greatly facilitate the work of the editors and correspondingly hasten the publication of your folios." The suggestions given refer specifically to the textual material of the folios.

4. "Suggestions to Authors of Economic Papers," by S. F. Emmons, 1906.

Emmons' pamphlet consists of 13 pages. Detailed suggestions are given for the preparation of what today are called reports on mining districts.

5. "Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey, with Directions to Typewriters," by George McLane Wood, editor, 1909.

This is the first edition of "Suggestions to Authors." It consists of 50 pages, made up in Survey bulletin format. It represents a considerable expansion and revision of the earlier material and sets a general style that has been followed in all later editions.

6. "Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey, with Directions to Typewriter Operators," second edition, by George McLane Wood, editor, 1913.

In the same format as the first edition, the second edition had grown to 64 pages. In a prefatory note Wood says, "The edition now published contains some new material and discusses in greater detail several suggestions that were made in the first edition. In the compilation of both editions valuable aid has been rendered by Mr. Bernard H. Lane, assistant editor."

7. Same title and author, third edition, 1916. The work had now grown to 120 pages, and was in the same format as earlier editions. The expansion was largely reflected in more specific suggestions on an increased number of topics.

8. "The Preparation of Illustrations for Reports of the United States Geological Survey, with Brief Descriptions of Processes of Reproduction," by John L. Ridgway, 1920.

In a format like that of "Suggestions to Authors," Ridgway's volume consists of 101 pages. It is concerned wholly with illustrations and the processes of reproducing them.

9. "Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey," by George McLane Wood,

fourth edition, revised and enlarged by Bernard H. Lane, editor, 1935. It has been reprinted several times since 1935.

This revised and enlarged edition of 126 pages was prepared by Bernard H. Lane after the death of Wood. Lane had succeeded to the position of editor on Wood's retirement.

10. The present volume, the fifth edition, represents a thorough revision and enlargement of the fourth edition. It is presented without specific authorship as the joint work of numerous members of the Survey who have provided material from the viewpoints of the author, the critic, the manuscript processor, the administrative reviewer, the illustrator, the editor, and the printer. The contents of the volume are applicable to all reports prepared under Survey auspices—the reports that are issued by the Geological Survey itself and those that are issued, after the Director's authorization, by cooperating agencies and by scientific and technical societies. However, it should be pointed out that the form of the Survey-issued reports differs in varying degrees from the form of the publications of these societies and agencies. The subject of form as discussed here therefore applies only in part to Survey-authorized reports that are printed by these agencies and societies.

The responsibility for the preparation of the volume was placed in the hands of a Geological Survey committee designated in 1955 for that purpose. The committee members and the Survey units they represented were as follows: Hugh D. Miser, chairman of committee (Office of the Director); Michael S. Chappars (Office of Texts); Chalmer L. Cooper (Office of the Director); Charles H. Davy, succeeded in 1956 by Calvin S. Maltby (Topographic Division); Arthur Johnson with H. G. Barton, alternate (Conservation Division); Nevin B. Johnson (Office of Illustrations); Charles L. McGuinness (Water Resources Division); Robert L. Moravetz (Office of Publications); A. Williams Postel (Office of Geologic Reports); John C. Rabbitt, succeeded in 1957 by Mary C. Rabbitt (Geologic Division). Numerous other individuals who were invited to participate in the preparation of the volume gave unstintingly of their time and talents; and to them the committee expresses its thanks and appreciation.

CONTENTS

SUGGESTIONS TO AUTHORS OF THE REPORTS OF THE UNITED STATES GEOLOGICAL SURVEY

INTRODUCTION

Knowledge acquired by the Geological Survey through programs of research and investigations has no value to the public if it remains in office files or in the minds of the scientists and engineers who did the work. The full discharge of the Survey's responsibilities is attained only by making its acquired knowledge available promptly and effectively to all people who will find it of interest and use. And, to insure effectiveness, reports must be not only accurate but so clearly and simply written that they are easy to read and understand.

Efforts by the Geological Survey to attain high quality in reports are necessarily group efforts. The largest contribution is made by the author, who has assembled facts, has worked out ideas to explain them, and has a direct personal interest in making the facts and ideas clearly and effectively known. The Geological Survey encourages that interest, recognizing that it is an essential ingredient of the high morale of the members of the Survey. Authors should keep in mind, however, that the Survey has a proprietary interest in all their manuscript reports and as proprietor may dispose of the reports, or require that they be changed before publication, as it sees fit. The Survey generally exercises its proprietary interest only to the extent of seeing that a report is scientifically and technically sound, will reach the proper audience, and will reflect credit on both the Survey and the author. To these ends, each report is reviewed by the author's fellow workers, supervisors, and staff officials, who bring to bear upon it their specialized knowledge, skill, and judgment to assure a sound product. In its final form each Survey report is the product of team effort in which many persons do their share—even though most of them remain anonymous.

There is no easy way to prepare reports of high quality, any more than there is an easy means of carrying out research to sure and outstanding conclusions. Each task calls for intensive thinking and for persevering work. The author bears the primary responsibility and correspondingly faces the most difficult task. To aid him is the chief purpose of this volume.

The subject matter of the volume is arranged under several principal headings. First, a summary is given of the Survey's publications: the

historical basis for them, statistics as to what has been issued in the period 1879–1957, and a list and description of the several series of reports and maps in which material is being published. Next are outlined successive steps that the author will normally take from the start of a project to his final proofreading of the text and illustrations. Under the third broad heading is brought together much detailed information about the form and content of reports. The fourth part of this volume is devoted to advice on expression—what to seek and what to avoid. A fifth major part of the volume bears on the most common questions of typographic style that affect Survey publications. The final sections of the volume give instructions for typing manuscript copy and correcting the galley and page proofs; also they include a few useful tables and a discussion of the purpose and content of press releases.

PUBLICATIONS OF THE GEOLOGICAL SURVEY

HISTORICAL BASIS FOR PUBLISHING REPORTS AND MAPS

Even before the Geological Survey was designed and authorized, those who urged the need for such an agency foresaw clearly that its scope must include two complementary and integral functions—the making of investigations and the publication of results. By legislation passed in June 1878 Congress called upon the National Academy of Sciences "* * * to take into consideration the methods and expenses of conducting all surveys of a scientific character * * * and to report to Congress * * * a plan for surveying and mapping the Territories of the United States * * * and also to recommend to Congress a suitable plan for publication and distribution of reports, maps, and documents, and other results of the said surveys." The National Academy shared in that concept of dual functions and recognized also that the material to be disseminated should embrace the scientific as well as the strictly economic or utilitarian. Hence, in its reply the Academy suggested language suitable for the purpose. In the Act of March 3, 1879, creating the Geological Survey, Congress included the following authorization:

> The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos.

Other legal provisions that authorize the publication and dissemination of the results of the Geological Survey's investigations are contained in later acts of Congress, including the annual appropriations acts.

PRODUCT OF THREE-QUARTERS OF A CENTURY

The "First Annual Report," appearing in 1880, was merely a preliminary description of the plan of bureau organization and publication. By 1882 the program was well under way. In that year were issued the "Second Annual Report" (which included masterly papers by Dutton, Gilbert, Emmons, Becker, and King) and 2 monographs, 1 by Dutton and 1 by Becker. The series of annual reports and monographs were continued and expanded, and other series were added from time to time—bulletins, in 1883; annual volumes of statistics on mineral resources, in 1883; geologic folios, in 1894; water-supply papers, in 1896; professional papers, in 1902; a series of informal reports called circulars, in 1933. After the "Twenty-second Annual Report," for the fiscal year 1900–1901, technical papers such as had theretofore been included in the annual reports were issued in other series. "Mineral Resources of the United States, 1923," the last of the kind to be published by the Geological Survey, marked the transfer of the Division of Mineral Resources to the Bureau of Mines, in 1925.

In the three-quarters of a century since its inception, the publication program of the Geological Survey has resulted in an impressive output of scientific and technical information. By June 30, 1957, the Survey had issued more than 3,450 book publications—289 professional papers, 1,048 bulletins, 1,375 water-supply papers, 398 circulars, 21 annual reports that contain technical papers, 55 monographs, 40 annual volumes on mineral resources, and 227 folios. Because many of the "books" contain numerous separate reports, the total number of individual reports (even excluding the descriptive articles on commodities in the volumes on mineral resources) is still more impressive, for they aggregate nearly 6,000 individual reports.

During the same period more than 20,000 different maps have been published, and many millions of copies have been distributed to countless users and put to a wide variety of practical uses. The greatest number of maps are standard quadrangle maps showing the topography of areas in the United States. However, a substantial number portray the geology, hydrology, mineral resources, and other aspects of knowledge derived from Survey work; several hundred of these maps bear short descriptive texts, which in fact constitute reports similar to many of those in the book publications.

In addition to the material issued by the Geological Survey itself, a very large amount of information resulting from its studies has been made available to the public in thousands of officially prepared reports and papers that have appeared in publications of cooperating Federal, State, and other governmental agencies and in journals of scientific and technical societies.

CURRENT SERIES OF PUBLICATIONS

Every author should be familiar with the several kinds of reports, maps, and charts published by the Geological Survey. If he understands the distinctions among them and the criteria for final decision as to the series in which his material will be published, he can anticipate the probable decision and thus prepare his material more efficiently.

For ready reference, a condensed list of the current series is given below. It is followed by brief descriptions of the several series, together with some suggestions and criteria for fitting proposed publications into them.

For completeness, the list includes, as its last five items, the topographic and related maps of quadrangles and other areas. However, as almost all such maps are prepared and thoroughly checked according to engineering specifications and under uniform procedures, they do not for the most part bring up the kinds of problems considered in this volume, hence they are not discussed here.

Book publications:

- Formal series of reports
  - Professional Papers
  - Bulletins
  - Water-Supply Papers
  - Monographs
  - Geologic Folios
- Informal series of reports
  - Circulars

Maps, charts, and atlases:

- Geologic Quadrangle Maps (GQ–1 and succeeding numbers)
- Oil and Gas Investigations Maps (OM–1 and succeeding numbers)
- Oil and Gas Investigations Charts (OC–1 and succeeding numbers)
- Coal Investigations Maps (C–1 and succeeding numbers)
- Geophysical Investigations Maps (GP–1 and succeeding numbers)
- Mineral Investigations Field Studies Maps (MF–1 and succeeding numbers)
- Mineral Investigations Resource Maps (MR–1 and succeeding numbers)
- Miscellaneous Geologic Investigations Maps (I–1 and succeeding numbers)
- Hydrologic Investigations Atlases (HA–1 and succeeding numbers)
- Maps of United States, States, and special areas that do not fall in regular series. These include geologic maps, oil and gas maps, coal maps, and others.
- Geologic map indexes (of States)

Topographic maps (including contoured, hypsometric, and shaded-relief maps)
Base maps of United States, States, and special areas
River survey maps
Topographic map indexes (of States)
Status maps (showing progress of work and aerial photography available)

For general guidance, the Director has indicated that reports to be published by the Geological Survey should be issued in one or another of the formal series of book reports: (a) if they are considered to be of such wide interest as to justify their placement in permanent libraries through established exchange and depository lists; (b) if their general distribution to the public is to be through sale by the Superintendent of Documents; or (c) if they are large and bulky, or are accompanied by necessarily large and complex illustrations.

Professional papers include comprehensive reports on the results of resource studies and of topographic, hydrologic, paleontologic, and geologic investigations, that are of large size or have illustrations or tables requiring a large page size; they include also longer contributions to the literature on scientific and engineering subjects.

Bulletins include either final or progress reports on the results of resource studies and of topographic and geologic investigations; shorter contributions to economic and general geology; and descriptions of Survey instruments and techniques. Among other kinds of reports included in the bulletin series are bibliographies, geophysical abstracts, and contributions to geochemistry.

Water-supply papers include reports on the geology, hydrology, quality, recoverability, and utilization of water resources. They include also several series of statistical reports on streamflow, floods, ground-water levels, and water quality.

Monographs are occasional large and exhaustive treatises on outstanding areas or scientific subjects; none has been issued since Monograph 55, in 1929.

Geologic folios are parts of "the geologic atlas of the United States." They include geologic maps and descriptions of quadrangles and other areas and also geologic maps of some States. No folios have been issued since Folio 227, in 1945.

Circulars provide an outlet for reports for which a simpler and less permanent format is deemed adequate. They are intended to be as sound scientifically and as accurate as the reports published in the formal series; but in general the treatment of their subjects is less comprehensive and final; and the necessary illustrations are fewer and less complex and are generally published in black and white; only in exceptional cases may simple multicolor illustrations be used.

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Reports may be issued as circulars if they are of relatively local or restricted interest, or if they are of relatively temporary usefulness. Preliminary or progress reports should generally be limited to the direct aims of the investigations and should contain only a minimum of the background material normally included in final reports.

The publication of geologic quadrangle maps was begun in 1949, and the maps were converted later to a numbered series. They are multicolor maps which are deemed of high quality in the accuracy and degree of detail of the geologic mapping; for their base, contoured topographic maps are used. They are accompanied by brief texts and (if essential and appropriate) by structure and columnar sections and other graphic material, all of which must fit a certain size and format.

The numbered series of "investigations" maps, charts, and atlases bear names that indicate the subject matter covered. These series include appropriate material originating in any unit of the Survey. A uniform size has been adopted for the hydrologic investigations series, in which the atlases consist of one or more sheets 22 by 27 inches or one sheet 44 by 27 inches folded once; the content and makeup vary from atlas to atlas, as the series is designed to accommodate a wide range of hydrologic information best presented on large sheets rather than in book form. Within any one of the other "investigations" series, more variations in format and sheet size are required to accommodate the variations in shape and extent of the areas covered and in the publication scale of the mapping. As implied by its name, the miscellaneous geologic investigations series includes a wider range of subject matter, for it was established to provide an outlet for several types of maps that do not fall logically into any of the other "investigations" series.

Maps that do not accompany reports include geologic maps of the United States, individual States, and special areas and the unnumbered series of geologic map indexes of States; their textual material generally consists only of brief statements under the boxes in the explanation and of citations to the sources from which the map material is drawn.

Open-file reports include unpublished manuscript reports, maps, and other material and are made available for public consultation and use. The date and places of availability for consultation by the public are given in press releases or other forms of public announcement. These reports are a medium for making information available to all interested persons. They are a nonpermanent form of publication that may be cited in other publications as sources of information. They are not considered to be a part of the formal literature and are not listed in the annual bibliographies of North American geology.

Many open-file reports are replaced later by formally printed publications, and those so replaced should no longer be cited in Survey publications. (See p. 105.)

SUCCESSIVE STEPS BY THE AUTHOR

In this section are outlined the successive steps that an author will normally follow in planning and writing his report, beginning when an investigation is authorized and ending with his final review and checking of proof just before printing. Suggestions are also offered about procedures and practices that he may find useful at different stages. This section is brief, generalized, and mainly chronologic; the author is referred to subsequent longer parts of this volume for the many details of form, content, arrangement, and expression that are required or suggested for reports of the Geological Survey.

PLANNING THE REPORT

BEFORE BEGINNING INVESTIGATION

The course and results of investigative or research projects can be foreseen only with widely varying degrees of clarity and assurance. If a project is rather specific—for example, if a geologic and economic survey is to be made of a particular area in which the objective is well defined and the stratigraphic, structural, and other features are fairly well known and understood—its duration and results can be forecast with reasonable assurance. On the other hand, if a project involves research in problems that are little known or less tangible, such predictions may prove faulty.

Nevertheless, to the extent feasible, the scientist or engineer in consultation with his supervisor should estimate and tentatively plan the following:

1. The time that will be needed for the investigation itself and for the collateral and supplemental tasks such as searching the literature, making and checking calculations, and making laboratory tests.
2. The number, kind, and size of the reports and maps that will be justified by the results and the length of time that will be required to prepare them for first transmittal to the supervisor.

If the maps or other illustrations that are planned will be complex and costly to publish, counsel should be obtained from the supervisor and other responsible persons concerning the most efficient methods of preparation.

AFTER COMPLETING INVESTIGATION

After the investigation and its collateral and supplemental tasks have been completed, the author should again confer with his super-

visor, who is aware of the information gathered and the ideas developed. Together, the author and the supervisor should do the following:

1. Review and evaluate the results of the investigation, and decide which are worth reporting.
2. Consider the kinds and number of persons and groups who may be expected to find those results of interest and use.
3. Discuss the form in which the information and ideas to be reported can be presented most clearly and effectively.
4. Reach a final working decision as to the types, general size and scope, and number of reports or maps, or both, that the author should prepare.
5. Make a more definite estimate of the time that will be required for the author to prepare and revise his first draft and the date when he will transmit it formally to his supervisor for review. This estimate should be as realistic and accurate as possible. Adherence to the time schedule should be fully recognized by the author as an official obligation. He should realize that he will be judged by the degree of promptness and care with which he performs that task, just as he is by the effectiveness with which he carries out any other assignment. Substantial delays are permissible only if there are officially prescribed interruptions.

Guided by the general decisions reached in conference with his supervisor, the author is now ready to draw up a more detailed plan and outline for his report. This task is perhaps the most constructive step in the author's program; certainly, in proportion to the time required it will be the most profitable step if it is done carefully and thoughtfully. Even the most experienced author cannot afford to start writing without some sort of advance planning. If he should be so rash, he will fritter away time in marshaling thoughts to set down, and he will waste even more time later in recasting the manuscript in an attempt to supply the missing logic and completeness. The hours or days required to draw up a well-rounded outline are, in the long run, a thoroughly justified investment.

As a background the author will already possess, or should acquire, general familiarity with the order in which topics are presented in Geological Survey reports. He may inform himself on this matter by examining recently published reports and also by reading the next section of this volume, in which many details of form and arrangement are discussed and explained. He will note that in many reports a rather conventional pattern is used, particularly in reports that summarize the observations made in a survey of a district and that present scientific and economic conclusions. He will note also a greater diversity of arrangement in reports on more abstract research

investigations, where the order of treatment must be chosen to bring out most clearly and convincingly the complex problems that were studied and the evidence upon which the resulting theories and conclusions were based.

From these examples and suggestions and with due thought to the nature of his material, to the purpose of the report, and to the needs of the readers whom he plans to reach, the author can determine the most logical and appropriate order to be followed.

The organizational pattern thus selected may then be conveniently outlined on paper as a tentative, more or less detailed table of contents, with headings and subheadings to indicate the topics to be discussed. For a rather brief and simple report, such a generalized outline may suffice in arranging the material and undertaking the actual writing. The author's task is to sort and appraise his notes and observations, to discard what is irrelevant or unnecessary, and to arrange what he will include. In so doing, he may wish to set down his ideas on cards, or on sheets of paper of uniform size, with only one topic on each card or sheet. Later, each topic may be developed in greater detail. The cards or sheets help to prevent the omission of important data or the inclusion of irrelevant material. They also give flexibility, permitting the author to add, subtract, combine, or rearrange as he proceeds, so as to insure an orderly and well-balanced presentation.

During this planning stage the author should also reach tentative conclusions about the illustrations and tables to be used. Illustrations are important adjuncts to a scientific report; some of them show what could not possibly be described in the text, and others show at a glance what would require many words to explain. Photographs may be used to good advantage but should be selected with discrimination, as they must illustrate some significant point or feature better than can be done in any other way. Tables also have their place, for they enable the author to present information in a concise and orderly manner. They permit a quick and clear comparison of data that would be difficult to carry in mind if given in the text.

One other point should be borne in mind at this stage. If advice and decisions about the use of new geographic and geologic names will be required from the Board on Geographic Names or the Survey's Geologic Names Committee, the author should anticipate his needs as early as possible. (See p. 79–99.)

WRITING THE FIRST DRAFT OF THE REPORT

Writing the first draft of the report requires time and labor and is the longest and most arduous stage in the whole course of authorship. To set forth his information and ideas clearly, concisely, logically, and convincingly on the written page and to prepare copy for necessary

illustrations, the author is called upon for intensive thinking and persevering effort. Conscientious and thorough performance of these necessary tasks brings many rewards—personal satisfaction to the author, readier subsequent handling of the manuscript by fellow workers, higher quality and quicker publication of the report, and greater usefulness of the report to the reader.

The methods by which authors prepare their manuscripts vary widely, and no rule or guide can be described that will fit the needs of all. Each author develops his own techniques and habits.

With an outline of his topics before him, the author usually finds it preferable and more natural to write on one topic and tentatively finish it before taking up another. This practice leads to continuity of thought and completeness of coverage. However, not all sections need be written in the order in which they will appear in the finished report—for example, the abstract and the introductory material at the beginning of a report are generally best prepared after the rest of the text has been written.

Writing the manuscript may be done in any of several ways, each of which has many adherents. One group recommends that the author focus attention solely on the subject matter in the first draft, writing it completely through without interrupting the flow of thought to criticize and improve the writing during the process. The adherents of this group believe that, although the product will not be smooth, it will have unity and will be a clear exposition of the author's ideas.

Another practice, which is generally preferable, may be followed in attaining a creditable manuscript. An author pursuing this practice does not write his thoughts on a topic until after he mentally assembles those thoughts in their best order and ponders the words and the sentences by which he can express them clearly, logically, and forcefully. He writes deliberately—weighing, both before and during the writing, not only what he will say but also how he will say it. When this practice is followed the resulting first draft will certainly be much superior to a more rapidly written draft and later will not require so drastic a recasting as otherwise might be needed to give it sound construction and expression.

Most authors wisely read and work over their manuscripts many times. An author will find it helpful to check for logical order of treatment, prominence given to significant features, completeness, accuracy, irrelevant material, confusing statements, and repetition, as well as for compliance with the requirements and suggestions given in this volume.

As a part of this stage the author will also prepare or assemble preliminary or final copy for the necessary maps, charts, diagrams, and photographs, which illustrators will later put in form for publica-

tion. Whether the author should complete this task before or during the writing of the manuscript will depend on the complexity of his material; but at least the tables should be compiled and the illustrations and their titles should be definite enough that references to, and discussions of, them can be included at appropriate places in the text. The requirements and suggestions as to form and methods to be used for the illustrative copy are given on pages 122–134.

While the author is preparing the text and illustrations of the manuscript report, he will profit greatly from consultation with fellow workers on both general and specific problems. Also, the author may wish to have all or parts of the manuscript reviewed in a preliminary way by associates who are familiar with the subject matter. Such informal review often pays large dividends, and it requires comparatively little effort on the part of either author or reviewer.

TYPING AND CHECKING REPORT FOR FIRST TRANSMITTAL

The next step is to have the text typed, or retyped, in proper form for the attention of other reviewers. Though several stages of review and revision will follow, and eventually some or perhaps many pages must be retyped at least once before the manuscript is ready to go to the printer, the first typing should be done in accordance with the practices specified on pages 218–220. If it is expected that the report will have to go to several reviewers, consideration should be given to preparing several copies so reviewers can work on the report simultaneously. The advantages of this procedure must be weighed against the additional effort required to reconcile comments and suggestions and transfer them to a single copy.

When the typescript is delivered, the author should proofread it thoroughly to eliminate typographical errors and omissions. He should also use this opportunity to check the accuracy of the whole report, including illustrations, quotations, and citations of publications, and to be sure that he has complied with all requirements as to content, format, and supplemental information to be furnished.

The author should then submit to his supervisor the completed document, accompanied (if necessary) by a suitable memorandum of transmittal explaining any special circumstances that may exist.

REVISING REPORT AFTER REVIEW

The report is reviewed within the originating branch and within other branches and divisions to which the manuscript is sent for examination of the parts that relate to their fields. The reviewers are specially qualified by their knowledge of, and interest in, the problems discussed. Their desire is to assure the scientific validity of the report and the clarity of its presentation. To that end they

point out any weak or doubtful spots in text and illustrations by means of marginal notes or interlineations, or (if their questions, criticisms, and suggestions are numerous or involved) by means of attached memorandums.

The author, knowing the purpose of the review and the spirit in which the reviewers' comments are made, should try to profit by them. He should give every comment thoughtful consideration. Where suggestions are acceptable he should make the appropriate changes or corrections. Wherever he differs with the reviewer he should indicate on the manuscript or on the margin of the attached memorandum why he differs and whether he has made any changes. If the differences of opinion are substantial, or if there seem to be misunderstandings, the author may explain his views in written comments and attach them to the manuscript. Where possible, informal consultation and discussion between the reviewers and the author are highly desirable to clarify viewpoints and reach agreement.

Further review of manuscripts includes the following: Maps, diagrams, and other illustrations involving geology are examined by the geologic map editor, who looks for errors and inaccuracies and also indicates changes in format necessary to assure clearness, conformity to Survey practices and standards, and economical reproduction. Reports that include stratigraphic names and correlations are examined by the staff of the Geologic Names Committee to insure full consistency and compliance with the officially established usage of the Geological Survey. (See p. 79–91.) Instructions from the Geologic Names Committee must be followed strictly, unless additional discussion leads the committee to modify those instructions.

Reviewers' comments and other papers should be kept intact with the manuscript. Their markings on the text and on the illustrations must not be erased.

It should be unnecessary to emphasize that, after the Director approves a manuscript for publication or for other release, no change in or addition to the text or illustrations, except of an editorial nature, may be made, unless the proposed change or addition is submitted through official channels, is suitably endorsed, and is formally approved.

REVISING REPORT AFTER EDITING

The editing of reports has a dual purpose. First, the editorial staff prepares for the printer all manuscripts that are to be published by the Geological Survey. This work includes the examination of the nature and rank of headings, the form of the footnotes and of the citations of publications, the use of geographic and geologic names, the form of tables and sections, and the various features of typo-

graphic style—such as sizes and styles of type, capitalization, punctuation, and spelling—as well as many other details. Much of this work is done according to prescribed rules, such as those of the "Style Manual" of the Government Printing Office, or decisions, such as those on the usage of geologic names and those of the Board on Geographic Names.

Second, the editors endeavor to approach each manuscript as detached but sympathetic readers who look at it from the viewpoint of the people to whom the publication ultimately will go. They try to understand the author's ideas and to help him express those ideas as clearly and concisely as possible. To that end they make suggestions to the author concerning the arrangement of matter, the paragraphing, the correction of faults in grammar or rhetoric, the clarification of obscure passages, the elimination of repetitious or irrelevant matter, and many other features, such as are discussed on pages 134–191.

When an edited manuscript is returned to the author, he should examine carefully the suggestions and corrections made. These editorial suggestions concerning arrangement, expression, and clarity have been made for the purpose of improving the report, and they should not be ignored by the author. He should make sure, of course, that none of the revisions change the intended meaning. If any of the changes seem to him undesirable, he should confer or correspond with the editor through his supervisor and try to reach agreement without delay. Changes that would conflict with the official approval that has been given the report must, of course, be avoided.

EXAMINATION OF DRAFTED ILLUSTRATIONS

After maps and other illustrations have been drafted by illustrators, they are referred for examination to several designated persons, including the map and text editors, and to the author through his supervisor. If the author is not available, they are referred to some other qualified person. Long experience has shown that, despite the skill and care of the draftsmen, errors may be found in the drafting itself and in the wording on the illustrations. Experience has also shown that some errors may remain undetected. Inasmuch as the author has the greatest familiarity with the detailed information shown in the illustrations, his is the largest responsibility at this stage. He should scrutinize the drawings with the utmost care and thoroughness before approving and returning them. Detailed instructions are given on pages 132–133. Corrections or other changes made on illustrations may require changes in the text of a report. Important revisions must be submitted through official channels and be approved.

PROOFREADING

The last steps taken by the author before his manuscript is published are the examination of the galley and page proofs of the text, and the proofs of maps and other illustrations. These tasks should be performed with care and thoroughness. Moreover, there is special need for promptness to avoid delay in publication.

The chief purpose of examination of proof is to detect errors introduced by typesetters and lithographers in reproducing the text and illustrations. Because the manuscript was fully prepared and perfected before its transmittal for reproduction, the author must not attempt further factual revision in the proof stage. Some minor changes from copy may be permitted in galleys, particularly to correct errors of fact that may have escaped notice during the earlier reviews. Changes in page proof or in the proofs of illustrations are costly and are permitted only to correct definite errors. Any other changes will be permitted only upon exceptional justification. (See p. 133–134, 220–224.)

FORM AND CONTENT OF REPORTS

The form of a report refers to its organization and mechanical makeup; the content comprises the text and the illustrations and the style in which they are expressed or presented.

How true is the oft-repeated statement that a person's understanding of a subject can be measured by his ability to discuss the subject so that others can understand it as well! Certainly, unless the findings of a scientist or an engineer are presented so that they are comprehensible, their significance is lost. The writer should make a sharp distinction between facts and his interpretation of facts, and should present both data and interpretations concisely and straightforwardly. The language used should be so clear that the reader will be in no doubt as to the facts and interpretations presented; but it should not be so abbreviated or unusual as to call attention to the style. Every conclusion should be expressed accurately and completely, with explicit statement of the limitations of knowledge involved.

Technical terms are an aid to the reader if they represent precise and significant concepts of the subject matter covered, and if the reader has, or is given, accurate definitions of the terms. When they are overused, they may display the erudition of the writer more than they enlighten the reader. No scientifically trained reader will object to a clear presentation in simple language, and such a mode of expression will be especially appreciated by the layman.

The audience to which the report is addressed should be kept in mind. It may be the general public, scientists in general, or a group of specialists. In a report directed to the general public, technical terms used without explanation should be confined to those found in an

ordinary dictionary. At the other extreme is a short paper on some new scientific development, directed largely to specialists in the field involved. Any attempt to include enough definitions to make the paper comprehensible to the general public would make it needlessly long. In such a paper it is permissible to use technical terms freely with little explanation, but it is always better to err in the direction of too much, rather than too little, explanation.

Between these extremes is the report meant to be read by persons having some scientific training, but mostly in fields other than that described in the report. To such an audience, technical terms are no hindrance if some clue is given to their meaning, but the author should avoid the jargon of his particular specialty.

Furthermore, although the Survey's first responsibility is to the American public, its reports are circulated and read widely abroad; the readers in other countries range from those who have a good understanding of English to those who have none and who will have to depend on translations of the report into their language. These uses reinforce the need for simple, clear English in Survey reports.

To illustrate some of the above ideas, a statement by O. E. Meinzer on "Facts, concepts, definitions, and terms," in Water-Supply Paper 494, is especially pertinent:

> The concepts of a science are based on the facts or truths that are known or believed to exist. The more fully and accurately the facts of the science are known the more definite and satisfactory are its concepts. * * *
>
> A definition is the expression of a concept by means of language. It should include all that is involved in the concept but nothing more. Obviously there are two kinds of pitfalls for the man who writes definitions—his concepts may be incorrect or hazy, or his command of language may not be adequate to enable him to express even satisfactory concepts accurately and completely. More often than is generally supposed lack of precision in writing is due to the vagueness and inaccuracy of the writer's concepts. The difficulties with language cannot be entirely overcome even by the best writers, because of the deficiencies of even so highly developed a language as the English. Many words, when critically examined, are found to be vague and ambiguous in their meaning. Hence, perfection in making definitions is an unattainable ideal. Approximation to what is desired is the best that can be hoped for.
>
> A scientific term is a symbol that represents a scientific concept. It has the same significance as the definition of the concept; it is neither more nor less precise. Scientific terms are not absolutely essential, but they are very convenient, and for this reason they are a real aid in promoting science. * * *
>
> * * * * * * *
>
> As the giving of names is an arbitrary matter, no single criterion for their selection is usually applied or can well be established. Among the principal criteria for the adoption of scientific terms are present use, etymology, original use, convenience, suggestiveness, and distinctiveness. However, none of these criteria can properly be applied to the exclusion of the others. Unanimity in present usage would, of course, be decisive unless possibly the term has been previously used for another purpose; but with respect to terms that are in controversy there

is obviously no approach to unanimity, and the question cannot generally be wisely decided by a majority vote. Moreover, the citing of authorities does not generally lead to decisive results.

SOME MATTERS OF ETHICS AND GOOD PRACTICE

A high standard of excellence in the form and content of the reports of the Geological Survey is a constant goal in all its endeavors. Because the author is a member of the Survey, he shares with it the responsibility for attaining high quality in its reports; conversely, the author and the Survey share the responsibility for unsound conclusions, misstatements, errors, and other blunders. Each person who works on a manuscript—the author, the reviewer, the editor, the illustrator—should devote his best efforts to assure a creditable report; expended effort that is less than the best from each person is unworthy and is a waste of time and labor. Furthermore, essential qualities of the teamwork of all persons engaged in the preparation and publication of the Geological Survey's reports include (a) the prompt performance of the duties of each person and (b) a constant maintenance of mutual respect on the part of all persons. The employment of these qualities of teamwork will facilitate and assure a safe and uninterrupted journey of the manuscript report, starting with its initial preparation by the author and ending with its publication.

In addition, an author is obligated to complete his manuscript report, the objective of each investigation, as soon as possible after the close of the investigation. If an author resigns from the Survey he is obligated to complete and turn in his report before the effective date of the resignation. Furthermore, even though he completes his report before he leaves the Survey and thus satisfies that obligation, he may place his good reputation in jeopardy and may embarrass the Geological Survey if, in working for a private employer in an area that he knows from Government experience, he uses unpublished information obtained during Government employment. His integrity and honor as a scientist are relied upon by the Geological Survey at all times to insure his conforming to high standards of personal and professional ethics in the use of information obtained through Survey investigations.

The responsibility for the prompt completion of a report does not rest solely with the author. It is shared in large measure by his supervisor, who should plan clearly and concretely with the author the one or more reports that will present the results of the investigation. This planning should be done before fieldwork or laboratory study is begun and should not be modified except for justifiable reasons that arise during the investigation or from other circumstances. By such planning, the author has both his goal and his duties in mind at all stages from the beginning of the study until the manuscript report is

completed. Good administration leads to effective performance at all times and avoids wasted effort and time. Also, the scientist's or engineer's progress on a project or manuscript should not be interrupted by assignment to new duties except under unusual circumstances. Such interruptions delay and may prevent the completion of planned manuscripts.

After the author completes a manuscript, the responsibility of handling the manuscript and its review fall squarely on the author's supervisor and on other supervisors. These supervisors have the immediate responsibility of keeping the manuscript moving and of avoiding inordinate delays on the desks of the author and the reviewers.

Numerous organizational units within the Geological Survey, each having its assigned responsibilities, perform the research, the investigations, the surveys, and the other work. Joint and integrated effort by these units is required for much of the Survey's work, whose objectives are nationwide, and therefore comprehensive, in scope. Thus one or many units may be responsible sources of Survey reports. The names of the originating units are not given in the reports unless there is exceptional need to place responsibility for specific work.

Like scientific endeavor in general, the work of the Geological Survey in recent years has been characterized by a pronounced increase in cooperation with other organizations. The nature of cooperative relationships, both formal and informal, should be described in the introductory, or another, section of the Survey's reports. In addition, if the investigation has involved formal cooperation, a concise description of it should be put on the cover and on the title page of book publications, and on separately published maps, charts, and atlases.

Extreme care is required of authors who write statements that bear directly on, or contain implications about, industrial situations, legal matters, and local, State, national, or Survey policies. The preparation of such statements may require the assistance of superiors or other recognized authorities.

An author who describes the results of his investigation and who also discusses the relation of his work to that of contemporaries or earlier workers will do well to devote most of his efforts to a clear logical presentation of his own subject; quotations and statements about others should be so skillfully incorporated that they contribute to, and do not distract the reader from, the author's logical presentation of his subject. The author's expressed opinions, especially about writers who have made mistakes or who hold contrary views, should always be presented in a tactful and dignified manner.

The author should obtain permission to use, and should give proper acknowledgment of, borrowed data or conclusions; he should give appropriate credit for data or conclusions contributed by collaborators; and he must obtain permission of mining or other companies to publish information obtained in confidence (such as mine maps and production data) and should indicate this permission in the manuscript or in attached documents.

Company names and trade names of equipment or material should not be used in Survey reports unless there are special reasons for their inclusion; these special reasons should be explained in a separate note accompanying the manuscript. This rule applies to photographs showing the names of companies or trade names on equipment or material.

Factual comparisons of all kinds of things are made in reports, but these should be skillfully worded so that they do not cause offense or wrong impressions.

Discussion of subjects that are outside the primary fields of activity of the Geological Survey requires citation of authorities. For example, statements giving the limits of chemical constituents in water acceptable for public supply should cite the U. S. Public Health Service. Also, statements concerning the limits of such constituents in water used for irrigation should cite an authoritative source.

An author should decide, early in his writing career, the way in which he wants his name to appear on his reports, and confusion will be avoided if the pattern is not changed. Use of his first name and middle initial is preferable. Where name similarities occur, a distinctive combination of names or initials should be used. The author's choice in this matter should be respected. It may be noted that, except where similarities are involved, bibliographic citations commonly give only the initials, unless there is only one given name.

Many other matters of ethics and good practice could be included in this section, but those discussed will serve in large measure for the orientation of the author.

SOME REQUIREMENTS OF THE WELL-PREPARED MANUSCRIPT

Some requirements of the well-prepared manuscript submitted by a Geological Survey author for publication are as follows:

1. It is typewritten on one side of fairly heavy bond paper of uniform size with a 1-inch margin of white space on all sides. The whole manuscript is double or triple spaced and the pages are numbered at the bottom.
2. It includes (a) a title page; (b) a table of contents headed "Contents"; (c) two copies of the list of illustrations headed "Illustrations—short list" giving the brief titles; and (d) two

copies of the list of illustrations headed "Illustrations—long list" giving complete titles and explanatory matter that is not included in the illustrations. It does not include the illustrations themselves—the drawings and photographs—which are enclosed in separate envelopes or packages. The manuscript pages on which headings appear are indicated in the table of contents; and the pages that contain the principal references to the illustrations are indicated in both the short and the long lists of illustrations.

3. It includes a list headed "Tables" of all numbered tables with an indication of the manuscript pages on which the tables are to appear.
4. It may include, before the table of contents, a foreword, a preface, or both.
5. It includes an abstract setting forth the salient facts and conclusions of the manuscript.
6. It is logically arranged in divisions and subdivisions, usually under not more than 5 orders of center headings and 1 order of italic side headings, and the headings accurately designate the subjects described or discussed. The relative rank of the headings is indicated by indention in the table of contents.
7. Its illustrations are all called figures except the plates that show groupings of photographs or drawings of fossils.
8. It contains references to all illustrations.
9. Its illustrations are numbered consecutively in the order of their principal references.
10. It contains, immediately adjacent to the principal reference to each illustration, the full title of the illustration and any explanatory matter that is not included in the illustration. The title and the explanatory matter are set off by lines above and below them.
11. Its quotations from other reports are correct, and the beginning and end of each extract are clearly indicated by quotation marks. Like the rest of the report, quotations are double or triple spaced.
12. Its citations of publications have been verified by the author and are in the form prescribed in this volume.
13. Its tables and descriptions of measured geologic sections are typed (double spaced) on separate sheets, are provided with headings where necessary, and are written in proper form for printing. The summation or footing of every column of figures is correct. Adequate margins are allowed.

14. Its geographic names are in the forms prescribed by the designated authorities, and its geologic names have been examined by the review staff of the Geologic Names Committee.
15. Its paragraphing has been carefully determined and indicated, so that few if any changes in this respect will be needed. Paragraphs are typed complete on the page.
16. Its expression has been well considered and conforms to the following requirements:
    (a) If the report is likely to be used widely by nontechnical readers it is written in straightforward English (simple exposition) with words in common use and of generally recognized meaning.
    (b) It is written in either the first or the third person, but is consistent throughout in this respect. A good rule to keep in mind is, "The subject matter rather than its author needs emphasis."
    (c) The subject of each paragraph is stated in a topic sentence, which is usually the first sentence of each paragraph.
    (d) The subject of each sentence has been carefully chosen and generally stands at or near the beginning of the sentence.
    (e) Adverbs and adverbial or other qualifying phrases are put in proper places.
    (f) Desired emphasis on a particular term or phrase is gained by proper arrangement, so that the emphatic word or phrase stands at the beginning or end of the sentence or clause.
17. The author of the manuscript and the typist have noted and profited by the suggestions and directions given in this volume.
18. The manuscript has been read carefully in its complete form by the author, who at the same time has had before him, for reference, the drawings and photographs intended for its illustration.

TITLE PAGE

The title page of a book report carries the title; name of author or authors; statement of cooperation, if necessary; and a brief statement characterizing the report. The title and authorship are repeated at the top of the first page of text—that is, the first page of the abstract, not the first page after the abstract. The title should be typed above the abstract about 2 inches from the top of the page, to allow space for directions to the printer and for volume title, if needed.

TITLE

The title should be as brief as it can be made, consistent with clarity; it should not serve as a summary of the report. However, it should not be so short as to fail to indicate the important aspects of

the report. The title is the first thing that is noticed by the reader; it will interest him, repel him, or leave him neutral. Care and thought in its preparation, therefore, will be rewarding.

If possible, the title should not begin with insignificant words or phrases such as "The," "A," "Notes on," "On." The first word should be an important one. Stringing together several unit modifiers in an attempt to shorten the title should be avoided.

The titles of many Survey reports are of certain types. Examples are—

Geology and Oil Resources of the Jonesville District, Lee County, Virginia.
Geology and Ground-Water Resources of the Baton Rouge Area, Louisiana.
Surface Water Supply of the United States, Part 7, Lower Mississippi River Basin.
Geology of the Flaming Gorge Quadrangle, Utah-Wyoming.
Geology and Ore Deposits of the Butte District, Montana.
Perlite Resources of the United States.

For many other reports, however, there are no such guidelines and the author must devise a satisfactory title.

STATEMENT OF COOPERATION

Many Survey projects are undertaken in cooperation with other Federal agencies or with State or other governmental agencies. The cooperation is expressed by a statement on separately published maps and on the title page and the cover of book reports. Some examples from recent Survey reports and maps are—

Prepared in cooperation with the Agriculture and Development Board of Kentucky.
Prepared in cooperation with the Virginia Geological Survey.
Prepared as part of a program of the Department of the Interior for development of the Missouri River basin.
Prepared in cooperation with the Montana Bureau of Mines and Geology.

DESCRIPTIVE STATEMENT

The author is expected to provide a brief statement characterizing the report, to appear on the title page of book reports. This statement should be placed on the title page of the manuscript when it goes forward for final review and approval. Examples of such statements from recent Survey reports are—

Revision of the pre-Tertiary stratigraphy of east-central Nevada.
Descriptions and illustrations of fossils of Late Cretaceous age, including two identified bivalve species, two gastropod species, and four cephalopod species.
A survey and restudy of one of the classic areas in geology.

AUTHORSHIP

Both credit and responsibility for the work and the conclusions represented in the reports and maps of the Geological Survey are

indicated by naming as authors those whose significant contributions to the investigations and the results are clearly identifiable. This practice is followed except in those reports that are the product of combined efforts of many persons acting as an organizational group and it is therefore impractical to single out and name individuals, except perhaps in a preface or in the text. Other exceptions where authors are not named include such organizational products as standard topographic quadrangle maps, base maps of the United States, base maps of the States, maps showing status of mapping in the United States, and similar publications.

When authorship is indicated by names of persons, the selection of the person or persons named is governed by practices that are summarized in the next several paragraphs. These practices refer particularly to book reports. The same principles concerning authorship also apply to maps, charts, and atlases, but the manner of placing the authors' names on them is dependent upon the format of each map or each series of maps, charts, and atlases.

The person or persons who had immediate and active charge of the investigation and (or) who prepared the report will naturally be named as the author or among the authors of the report. Other coauthorship is restricted normally to those who contributed very substantially to the conduct and results of the investigation. Usually those individuals in more general administrative or supervisory control over the investigation, or those who, as members of the party or group carrying out the investigation, performed relatively routine though valuable technical assistance, are not included as coauthors.

The naming of authors is appropriate for single reports, each with its own title. This is applicable regardless of whether such report is published as a complete "numbered publication" or as one of several chapters which together form a composite report published under a more general title indicating topical or geographic relationship.

In a single report covering principal or major work by one or more named authors, a supplemental or subordinate contribution on a related phase may be credited by adding to the main title and authorship the words "With a section on (subject) by (author)."

In a single report published as a complete "numbered publication" the author or authors are named on the title page and at the top of the first page of the text. Except upon appropriate justification and upon specific approval by the Director, the number of authors to be named will be controlled by the following rules: Not more than four principal authors are named if the report is almost entirely the work of one branch. The device described in the immediately preceding paragraph should be used where appropriate, to reduce the number of names of principal authors. If it is felt that more than four principal authors should be named, and if the subject presentation would not be damaged, consideration should be given to changing the single report into a composite-type report with authorship credit for individual chapters. If two or more branches collaborated in preparing a manuscript report, if the report has more than four potential authors, and if the composite-type report cannot be adopted, the authors of the printed report will be named from those persons who had immediate and active charge of distinctive fields of activity that formed an important and integral part of the investi-

gation; even in such cases it is expected that only rarely will there be occasion to name more than four authors. Where more than four persons could be considered as authors of a single report but they cannot all be named in accordance with the above provisions, three of them will be named followed by "and others," and those not named should be given due credit in the text or perhaps in a preface. In all cases, the chief of the lowest organizational unit supervising all the Survey authors will recommend the order and number of names listed.

For a composite report made up of several chapters by named authors the general title page omits any reference to authorship if the chapters have only a general topical or geographic relationship—for example, "Contributions" to various phases of Survey work—and hence are usually issued only in separate chapters. But if the chapters in a composite report are very closely related in the presentation of results of a coordinated investigation or project, any authorship on the general title page is indicated after careful consideration and administrative review and approval of the proposal of the sponsoring units, in accordance with currently existing policies.

No authors are named on the general title page of reports representing compilations of data obtained by a district, regional, or countrywide staff comprising too many persons to name except perhaps in the text or a suitable preface—for example, the annual surface-water and quality-of-water reports, and similar compilations. For these reports the general title page should contain the statement "Prepared under the direction of," to be followed by either or both of the following entries: (a) the names and titles of the appropriate division and (or) branch chiefs; (b) the names and titles of the appropriate technical supervisors, such as district engineers.

FOREWORD AND PREFACE

The foreword is a statement concerning the report by someone other than the author. The preface is a statement by the author himself. Both precede the table of contents, the preface after the foreword if a report contains both. A publication that contains both a foreword and a preface is the present edition of "Suggestions to Authors."

There is little need for either a foreword or a preface in most Survey publications. Care and thought in the preparation of the introductory material generally will eliminate the need for a preface, and there are few official reports about which anything needs to be said that cannot be said by the author. However, there are circumstances in which prefatory statements are appropriate. A publication may be unusually important; it may consist of a collection of papers, each with its own author and title, but pertaining to a central theme reflected in the title of the volume; or it may be the report of a cooperative investigation by the Survey and another governmental agency, with

or without joint authorship. Such publications may benefit by a foreword written and signed by some administrative official or officials, in which the importance and circumstances of the investigation are described.

A preface is a preliminary statement. It can be used to provide a prominent place for bibliographic information, such as the relation to other editions of the same report and to other reports on the same subject, and also for certain kinds of credits and acknowledgments that are not included on the title page. In organization-type reports, such as those on surface water supply of the United States, the preface can give credit to those who supplied data and who in other types of reports would be recognized as authors. A preface may be unsigned or it may carry the name or initials of the author.

TABLE OF CONTENTS, LIST OF ILLUSTRATIONS, AND LIST OF TABLES

The manuscript should include a table of contents, lists of illustrations, and a list of tables.

The table of contents, headed "Contents," should be a transcript of the headings appearing in the manuscript, except for repeated minor headings, which are omitted from "Contents." The table should be so written as to indicate by indention the relative rank of the headings—their coordination and subordination. The manuscript-page numbers should be those that have been finally assigned by the author, after the manuscript is complete. A specimen table of contents follows.

Contents

A proper scheme of headings is essentially a rational classification of the material in the paper, as can be seen by reference to the table of contents above. Coordinate or similar groups of matter ordinarily are given headings of similar rank. It is generally undesirable and unnecessary to provide headings of more than five ranks, for excessive refinement in subdividing the text confuses the reader. In the headings as given in the table of contents, only the first word and proper names should be capitalized; the relative rank of the headings will be shown by significant differences in type in the text of the printed report.

Headings preferably should indicate the things described or discussed in the text; thus the italicized words in the following headings are superfluous:

Description of the Cretaceous rocks
Discussion of ore deposits
Statement of theories of origin of the ore
Description of the mines
Table showing lead produced in 1954

The heading "General features," or a similar appropriate heading where applicable, should be used rather than "General statement," but a perfunctory heading need not be inserted over a brief general statement that precedes detailed descriptions for which suitable headings can be provided. Headings like "Introduction" and "Summary" are exceptions to this rule; however, some manuscripts contain too many headings of this kind, especially "Introduction," which is used in many places where it should be omitted or replaced by a heading denoting specifically the features considered in the text beneath it. One "Introduction" and one "Summary" are enough for a single report. If a summary of one of the subdivisions seems desirable, the heading should be worded to indicate the subject discussed—for example, "Summary of conditions affecting streamflow."

Two different lists of illustrations should accompany the manuscript. One of these, designated "Illustrations—short list," gives only brief titles and the other, designated "Illustrations—long list," gives the full titles and explanatory matter as they are to appear with the illustrations; an original and a carbon copy of each list should be provided. One copy of the long list and one copy of the short list remain with the text of the report; the carbon copies are used by the illustrators in their work on the illustrations. The manuscript page number given for each illustration in the two different lists should be that of the page containing the principal reference. It is especially important to give these page numbers, which serve as guides to the final numbering and placing of the illustrations, if any of the author's

figures are changed to plates. The short list in the text should follow the table of contents.

All illustrations should be listed as figures in the manuscript; they will be separated into plates and figures by the illustrators in cooperation with the editors, who will then make the necessary changes in the manuscript. An exception to this rule is the paleontologist's preparation of plates on which he groups figures that show photographs or drawings of individual fossils. (See p. 130–131.)

The manuscript form of a short list of illustrations is given below.

Illustrations—short list

A list of the numbered tables, headed "Tables," should accompany the manuscript. It should follow the short list of illustrations and give the number, full title, and manuscript page of each table. A representative list follows.

Tables

ABSTRACT

Because of the growth of scientific and technical literature, abstracts are an important means by which scientists and engineers are informed of the work of their colleagues. For the author the abstract is an opportunity to state in condensed form what he considers to be his real contribution to knowledge. Also, such a brief quotable summary is useful in informing the public of the Geological Survey's investigations.

An abstract should be a digest of the report and therefore should be written after the completion of the manuscript. It should be adequate for publication in an abstract journal and for the preparation of general indexes to literature. It should bring out not only

the major contributions related to the main subject of the report but also important incidental contributions to which the title gives no clue. Although the author's conclusions are the most valuable part of a report, he should indicate also, so far as necessary, the method of attack and the type of data used.

The abstract should clearly orient the paper in place and in function. It should supplement, not duplicate, the title in this respect and should not be merely an expansion of the table of contents.

As a general practice, headings should be avoided in an abstract but a systematic grouping of facts is desirable, and thus, in the abstract of a large report, headings may be needed. Statements generally should not be amplified by the use of examples.

A comparison of the present work with the work of others or with what has been known previously about a topic should be avoided. Reference to the work of others may be included, however, if the present work is a development from other work and it is necessary to show the basis from which the development was made. Citations and references to the tables, illustrations, or other material in the body of the report should be avoided. The abstract should not include information that is not given in the body of the report.

Bear in mind that an abstract should be informative; one stating merely that "this is discussed," "that was investigated," or "conclusions are given," does not meet the basic requirements of a suitable abstract. Be as specific on each point as space allows. Do not state what the report is about but what it tells. For example—

Do not write, "Subsequent movements along old faults occurred * * *" but, "Pleistocene movement along the late Mesozoic faults occurred * * *."

Do not write, "The sensitivity of the method is high" but, "By this sensitive method 10^{-8} gram of uranium can be detected."

Do not write, "The gravity anomalies in the area are discussed" but, "A gravity high of 25 milligals suggests that * * *."

Do not write, "Ground water in the Cretaceous rocks is described" but, "The Cretaceous rocks yield 50 to 150 gpm of moderately mineralized water to wells 800 to 1,200 feet deep."

No specific limits on the length of abstracts have been set for Survey reports. The author should keep in mind the value of a concise abstract to a busy reader and should write what is needed for the abstract but no more. Short, compact papers generally require actually shorter but proportionally longer abstracts than large, detailed papers. There are many different arbitrary limits set by scientific and technical journals on the length of abstracts, some in terms of a word limit and some in terms of a ratio or percentage limit. Many of these limits are dictated by the necessity of saving space.

The preparation of a good abstract is an art, to be acquired by care, thought, and diligent practice. An abstract that conveys a maximum

of information with a minimum number of words requires more writing and rewriting than does the preparation of other parts of the report. Examination of other abstracts for adequacy in providing factual information probably is the best guide to the preparation of abstracts.

INTRODUCTORY MATERIAL

Material introductory to the main body of text will vary greatly, according to the subject matter of the report. It should comprise a statement of the purpose of the investigation, the conditions under which the work was done, the plan of treatment of the subject matter of the report, acknowledgment of cooperation and favors, a summary of previous work in the field, and, if needed, notes on the most important prior publications. It should call attention to the author's outstanding conclusions on local or regional problems or on the further development of current theories and to any noteworthy differences between his conclusions and those expressed in earlier publications.

In reports in which it is appropriate to describe the geography, the attention given to that subject should depend on the district studied. If the district is well known, as are most parts of the United States, a brief statement on its location, routes of approach, topography, climate, vegetation, and other geographic features will suffice. Relatively complete information on these subjects is justified in the introductory material of only a few reports.

Assistance rendered by persons not connected with the Survey should be acknowledged. As a rule it is unnecessary to mention general assistance rendered by other members of the Survey; every investigation and the report giving its results have had the benefit of suggestions by the author's colleagues as a part of their routine work, and such contributions need not be recounted unless they are a noteworthy contribution to the investigation or report. Specific pieces of work, however, such as analyses, identifications of minerals or fossils, or computations, must be credited to the persons who made them. Such credits should be carried, if possible, in the tables, lists, or statements in which the work is reported. This credit is courteous; it is honest; it fixes the responsibility; and it is mandatory.

Titles of honor, office, distinction, or address, such as "Dr.," "Prof.," "Mr.," should be used only where the mention is personal, as in acknowledgment of courtesies or services. Such titles should be omitted from the names of authors cited, and they should be omitted from names of coauthors or scientific collaborators if first names or initials are given. In personal mention of a member of the Survey use "Mr." if the reference is preceded by his full name—his surname accompanied by his given names or initials. Note the following examples:

Mr. G. W. Jefferson guided the writer * * *.

The invertebrate fossils were identified by Mr. Reeside and the fossil plants by Mr. Brown.

Analyst, F. S. Grimaldi.

The economic geology is discussed by Mr. Thayer in part 2.

Acknowledgment is due Prof. C. A. Davidson of the University, St. Andrews * * *.

MAIN BODY OF REPORTS

The material that follows pertains to the main body of the reports—that part of the reports containing the observations made during the investigation and the descriptions, interpretations, and speculations derived from them, together with any conclusions that seem appropriate. Various aspects of the form in which this material should be presented in the book reports and in the different series of maps, charts, and atlases are covered under many headings. The organization of the subject matter of the different series of Geological Survey publications is discussed under the first heading below, and detailed information on the form and content of reports on water resources and reports on mining districts follows. Under many other headings (p. 58–134) is presented additional material that pertains to the form and content of the text and illustrations of Geological Survey reports.

ORGANIZATION OF SUBJECT MATTER

A manuscript report is its author's contribution of the results of a study. To fulfill adequately the purpose of the study, close and constant attention by the author and also by his supervisor is necessary to design the scope and length of the report, plan the organization of its subject matter, and plan for it to fit into the appropriate publication series. This planning should precede the start of fieldwork or laboratory study and should be appraised frequently and be modified only when there is a good justification. Such planning promotes efficiency in the study and in the preparation of the report and also assures prompt completion of an acceptable manuscript.

The organization of the subject matter of each report is determined, of course, by the subject and type of the study; by the title, purpose, and scope of the report; and by the individuality of the author. Thus the forms of organization of the reports present too much variety to describe or even to list. However, reports on many topics fall into some general patterns. These patterns, as well as others, can best be learned by examination of recently published reports on the subjects of current interest to the author.

The illustrations of book reports illuminate and explain the text. For separately published maps, charts, and atlases, however, the text (if any) explains the illustrations and should be organized accordingly. For the geologic quadrangle maps, the maximum length of text is specified. (See p. 128.) For the "investigations" maps, the

charts, and the atlases, the length of the text is not so strictly limited; but if they seem to demand a lengthy and elaborate text they probably should be prepared for publication as book reports.

The maps, charts, and atlases generally give titles and authorship at the bottom, above the text, and on the envelope or the cover sheet. The table of contents and the list of illustrations submitted with manuscript material are useful in its review but are not printed. An abstract is not needed, and the text should be kept as short as possible. Extensive meteorologic and similar data commonly used in book reports should not be given in the text. Concise tabular material is permissible, as are text figures. The map explanation should repeat little material carried in the text. Photographs should not be used except under special justification.

On some maps it is permissible to use an expanded explanation in place of a text. In such an explanation, short sentences can be used, or short phrases separated by semicolons. However, the style adopted for a map should be followed consistently. Acknowledgments and references to publications are used in the same manner as in book reports, but it is not necessary to repeat in the text any acknowledgments or credit lines carried under the map itself. Many map reports are of a preliminary nature and ideally should be followed by a book report of a more comprehensive and permanent nature.

The organization of some representative book reports is exemplified below by the tables of contents taken from six reports on a variety of subjects. These six reports present only a few of the many general patterns of organization. Additional tables of contents are not quoted here, because an author who seeks examples of outlines for his guidance will wish to examine and read numerous published reports on his field.

Geochemical Relations of Zinc-Bearing Peat to the Lockport Dolomite, Orleans County, New York, by Helen L. Cannon. Bull. 1000–D. 1955.

CONTENTS

Rapid Determination of Germanium in Coal, Soil, and Rock, by Hy Almond, Harry E. Crowe, and Charles E. Thompson. Bull. 1036–B. 1955.

CONTENTS

Geology of Pavlof Volcano and Vicinity, Alaska, by George C. Kennedy and Howard H. Waldron. Bull. 1028–A. 1955.

CONTENTS

Perlite Resources of the United States, by Marion C. Jaster. Bull. 1027–I. 1956.

CONTENTS

The Stratigraphic Section in the Vicinity of Eureka, Nevada, by T. B. Nolan, C. W. Merriam, and James Steele Williams. Prof. Paper 276. 1956.

CONTENTS

Water Resources of Southwestern Louisiana, by Paul H. Jones, E. L. Hendricks, Burdge Irelan, and Others. Water-Supply Paper 1364. 1956.

CONTENTS

REPORTS ON WATER RESOURCES

GROUND-WATER REPORTS

Reports on ground water differ greatly in their subject matter and objectives, and they have a highly diversified group of readers. Although no general outline can be given that will be suitable for all, the areal report, which gives a systematic description of the ground-water conditions in a specified area, is the most typical and should comprise the following parts:

(a) Introductory section, which gives the purpose and scope of the investigation, reference to previous work in the area, the plan of the report, and a general summary description of the area, including the geologic and ground-water conditions; (b) systematic description of each of the successive geologic formations in the area, including its water-bearing properties and the quality of its water; (c) either detailed descriptions of subareas, such as counties, townships, or geomorphic units; or a detailed discussion of the hydrology of the area as a whole, with emphasis on recharge, discharge, and potential availability of ground water; and (d) summary or conclusions, which em-

phasizes the significant results of the investigation. Each report is accompanied by an abstract.

The outline of the body of the report will vary somewhat with the nature of the area to be described. The author preparing to write an areal report should study the tables of contents of similar reports. As a rule the introductory section should include a general treatment of the geography, geology, and ground water. A description of the general geography and geology gives an adequate background and foundation for effective presentation of the facts on the occurrence, source, quantity, quality, recoverability, and utilization of the ground water. The description should not be more elaborate than is necessary to accomplish this purpose. Some statement of pertinent hydrologic principles also is warranted, but not an extensive presentation of general principles. During an investigation valuable geologic or hydrologic results may be obtained which deserve publication but whose details are not essential in the areal report. Judgment and expediency determine whether such material is to be included in the areal report or is to be presented in a separate publication. If the area has a stratigraphic section comprising more than a few units, the general description should include a table of the geologic formations, with a column for brief statements regarding the water-bearing properties of, and quality of the water in, each formation.

The systematic description of a stratigraphic unit should include the information that is usually given in geologic reports, such as distribution, thickness, lithologic features, age, and stratigraphic relations, insofar as the information is essential for effective discussion of the ground-water conditions. Detailed geologic data, such as lists of fossils identified, may be included, or published in a separate paper, according to circumstances. The systematic descriptions should include detailed information on the water-bearing properties of the formations, and on the pressure head and quality of the water, including reference to significant well data. The results of pumping tests and other types of aquifer tests, used in determining coefficients of transmissibility and storage, can properly be included in the systematic descriptions. Related data concerning such features as particle-size distribution, porosity, moisture equivalent, and permeability can be presented either in the systematic descriptions or in tables at the end of the report.

Detailed descriptions of subareas aid greatly in applying the facts and conclusions of the report to the determination of ground-water conditions in specific localities. Much skill is required in preparing the report on a subarea to avoid repetition of general statements and yet to describe adequately the conditions in all parts of the subarea. It is appropriate here to apply the data on hydraulic properties

of the water-bearing formations, as determined in the various tests, to the solution of hydrologic problems. These problems include determination of the recharge to—and the yield of—the aquifers under different plans of development, the mutual interference of pumped wells under different plans of spacing and operation, and the changes in quality and temperature of the ground water that may accompany its exploitation. Interpretation of the chemical analyses and discussion of geochemical problems also may be included in these detailed descriptions. Well records and logs, water-level measurements, and water analyses can be given in the sections on subareas, either in the text or in accompanying tables, or they can be presented in tables or notes at the end of the report. Data given in the tables should not, as a rule, be repeated in the text, although representative data may be cited to bring out specific points. Likewise, well sections given in detail in graphic form generally should not be duplicated by well logs.

In an increasing proportion of areal reports the emphasis is on the recharge, movement, and discharge of ground water in an area as a whole, or in hydrologically significant subareas within it, rather than on detailed nonquantitative descriptions of small political subdivisions such as townships. For information on conditions at a specific site in which he is interested, the reader refers not to a township description in the text but to detailed information in tables and on maps and graphs. Using this information, he is able to appraise the prospects of obtaining water in the desired quantity and of the necessary chemical and physical quality at any given site.

The areal report, no less than the special-purpose report, needs a concluding section, headed "Summary" or "Conclusions" or even "Summary of conclusions." In it are summarized the principal results of the investigation. It is the part to which those using the report as a basis for planning water-supply projects will turn most often and read most carefully, and obviously it should be prepared with extreme care.

Even in the report of a routine county investigation, involving no unusual problems, it is worth while to indicate in a brief summary the most important aquifers as potential sources of water.

Occasionally, as is common practice in engineering reports, a rather full summary may be placed at the beginning. Such a report does not need an abstract.

Although the primary purpose of most ground-water reports is to give information about general ground-water conditions in an area, such reports increasingly deal with specific or unusual conditions, or describe basic research on specific hydrologic phenomena. In such reports it is essential to define the purpose of the study and to emphasize the information that is of major importance, giving the sub-

ordinate matter only in sufficient detail to define the basic problem or to support the principal conclusions. Generally such a study is begun because a specific water problem requires a solution, but it usually results in the development of principles that are of wide application in other areas or in other phases of ground-water hydrology. Examples are the study of salt-water encroachment in southeastern Florida (Water-Supply Paper 1255); the study of salt-water encroachment and the application of electric logging to the definition of regional aquifers in southwestern Louisiana (Water-Supply Paper 1364); the study of evapotranspiration in the Safford Valley of Arizona (Water-Supply Paper 1103); the study of the effectiveness of structural barriers to ground-water flow in the Long Beach–Santa Ana area in California (Water-Supply Paper 1109); and the development of theory on induced infiltration in the Louisville area, Kentucky (Water-Supply Paper 1360–B).

Illustrations accompanying ground-water reports are of two general types—those that present detailed information not given in the text, such as the detailed geologic and hydrologic maps, and those that illustrate or summarize, in pictorial or graphic form, information that is presented in detail in the text or tables.

Most detailed maps are unavoidably complex. If a map is made to show data of several kinds it may become too complicated to be easily intelligible. In such circumstances the data should be presented on two or more detailed maps. By careful planning and by avoidance of unnecessary colors or patterns, two or more relatively simple maps can be published at less expense than one complex map that would show the same data. The explanation of at least the principal geologic map in every ground-water report should include a concise description of the water-bearing properties of each stratigraphic unit shown on the map.

Diagrams based on detailed data published in the report generally can be justified only if they aid the reader in obtaining a perspective of the outstanding results of the investigation. Therefore, they should be few and simple. Diagrams that illustrate only unimportant features or that are too complex to be readily understood should be avoided because they tax the time and energy of the reader needlessly.

Ground-water terms.—Although it is not practical to include in the present volume a list of new ground-water terms or to redefine old ones, some terms have been used with different meanings in ground-water reports so frequently that it seems advisable to call attention to them. As stated by O. E. Meinzer (Water-Supply Paper 494, p. 2), a scientific term is a symbol that represents a scientific concept. It has the same significance as the definition of the concept; it is neither more nor less precise. However, there should be general

agreement regarding it. Meinzer's definitions in Water-Supply Paper 494, on the whole, are still the most precise definitions of ground-water terms available.

Aquifer, ground-water reservoir; see Water-Supply Paper 494, p. 30.

Artesian water, water confined under pressure; confined water; see Meinzer, O. E., and Wenzel, L. K., chap. Xb, *in* Meinzer and others, 1942, "Hydrology," p. 451; also Fuller, M. L., *in* Water-Supply Paper 160, p. 9–15.

Effective porosity, a term similar to, but not necessarily equivalent to, specific yield; see Water-Supply Paper 494, p. 28.

Effluent flow, flow of water from the ground into a surface-water body; see Water-Supply Paper 494, p. 56.

Flood plain (two words), a surface, not a deposit.

Flood-plain deposits, deposits beneath and forming a flood plain.

Ground water, water in the zone of saturation.

Influent flow, flow of water into the ground from a surface-water body; see Water-Supply Paper 494, p. 56.

Meinzer (written lowercased), a synonym for the unit of permeability used in reports on ground water: gallon per day per square foot.

Permeability, field coefficient of; refers to prevailing conditions of water temperature, etc., in the field; may be expressed in terms of gallons per day through a cross section of 1 square foot under unit hydraulic gradient, or through a section 1 foot high and 1 mile wide under a gradient of 1 foot per mile.

Phreatic water; it has been used both as an exact synonym for ground water and, originally and most commonly at present, as a synonym for unconfined ground water—water having a water table.

Safe yield; see Water-Supply Paper 494, p. 55. The term has been defined in different ways and is subject to many qualifications; its use is therefore discouraged.

Specific yield, the ratio of the volume of water that will drain by gravity from a saturated rock to the total volume of the rock; see Water-Supply Paper 494, p. 28.

Storage, coefficient of, a term applied to both water-table and artesian conditions; as applied to water-table conditions it is practically, but not exactly, equivalent to the specific yield.

Terrace, a surface, not a deposit.

Terrace deposits, deposits beneath and forming a terrace.

Transmissibility (not "transmissivity"), **coefficient of,** a term referring to prevailing conditions of water temperature, etc., in the field; may be expressed in terms of gallons per day through a strip of the aquifer 1 foot wide extending the full height of the aquifer under unit hydraulic gradient, or through a section of the aquifer 1 mile wide under a hydraulic gradient of 1 foot per mile.

Vadose water, all water in the ground above the water table, including water in the capillary fringe and soil water (soil moisture).

Water table, the upper surface of a zone of saturation except where that surface is formed by an impermeable body; see Water-Supply Paper 494, p. 22.

Zone of aeration, the zone above the water table, including the capillary fringe; see Water-Supply Paper 494, p. 21–23.

Zone of saturation, the zone in which the rocks are saturated with water under hydrostatic pressure; see Water-Supply Paper 494, p. 21–23. Does not include any saturated portion of the capillary fringe, as the water in the fringe is not under hydrostatic pressure.

SURFACE-WATER REPORTS

Reports on surface water normally are of two general types—those that present the results of continuous records of streamflow at stream-gaging stations and those that deal with unusual hydrologic events, general hydrologic or hydraulic principles, or the hydrology of particular areas.

Surface-water reports of the first type contain records of daily and monthly discharge at each of the Survey's stream-gaging stations, and the records are accompanied by a descriptive text written in condensed form. As these reports are not written by a single author but are compiled from data collected by many individuals and prepared in several different offices, it is essential that they be kept uniform. Therefore, the manuscripts of these reports are prepared in accordance with specific instructions issued for that purpose.

Surface-water reports of the second type include those on floods, droughts, hydrology of specific areas, basic hydrologic or hydraulic research, and potential waterpower, and they usually contain both basic data and interpretive analyses.

In referring to records of discharge collected at a stream-gaging station, authors should give the station name in its entirety, except that the State name may be omitted if it is obvious from the context. Most station names contain "at" or "near," and these words should not be used loosely, as would be done if "in the vicinity of" were to be substituted for "near." Also, the article "the" should not be used in a station name, although "the" is used before river names in general descriptive writing. For example, write "discharge of Missouri River near Williston, N. Dak.," not "discharge of the Missouri River in the vicinity of Williston, N. Dak."

The word "standard" should not be applied to a stream-gaging station, weather station, or similar installation in place of a more explicit description. What is standard now may not be standard in a few years, and what one agency considers to be standard may not be so considered by another agency. "Standard rain gage," for

example, is a weak description. "Standard USWB [1] rain gage" is not much better. "Standard USWB nonrecording rain gage" is better, and "USWB 8-inch nonrecording rain gage" is even better.

In general, "standard" can be replaced by the name or initials of an agency; thus, "USGS [2] type A wire-weight gage" and "USWB class A evaporation pan."

In reports dealing with surface-water supply the 12-month period ending September 30 each year is called the "water year." The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year that ended September 30, 1957, is called "the 1957 water year," and this terminology is explained in each report. A period covering more than one water year is described by the inclusive water years, thus: "the 20-year period (water years 1938–57)," or "the average discharge for the 20 water years 1938–57."

In some hydrologic analyses, climatic years consisting of successive 12-month periods starting at some other specified time of year are used. In such analyses the climatic year is designated by the calendar year that includes most of the 12 months. Thus, the climatic year starting April 1, 1956, is called "the 1956 climatic year." However, to avoid confusion it is better to write: "the year starting April 1, 1956," or if a longer period is being described to give its beginning and ending months, thus: "the 20-year period April 1938 through March 1958." The period covered should be made clear even if to do so would require the use of a few more words.

In tabular work the column headings dealing with water years or climatic years usually read "Water year," "Year ending September 30," "Climatic year," or "Year starting April 1." Each year is then designated by only one calendar year; thus, "1957" rather than "1956–57" is shown on the line for the 1957 water year, and "1956" is shown on the line for the year starting April 1, 1956. In listing dates of events such as flood peaks, the full date is shown in the date column, thus:

Water year	*Date*
1956	Oct. 13, 1955
1957	Aug. 7, 1957

In surface-water reports only two kinds of averages are commonly used for streamflow—the arithmetic mean and the median. Unless specified otherwise, the term "mean" signifies the arithmetic mean obtained by adding all items together and dividing the total by the number of items. When "weighted mean" or "geometric mean" is used, it should be so designated. "Mean" and "median" are sometimes

[1] U. S. Weather Bureau.
[2] U. S. Geological Survey.

confused, although the two terms differ basically. The median is defined as the middle item when the items are arranged according to rank. The median is an average of position, whereas the mean is an average of quantity. The relative position of the mean and median of an array of data depends upon the skew of the data—that is, upon the deviation from the hypothetical normal distribution. In an array of streamflow data the median is almost always lower than the mean. The median is used advantageously to represent the normal discharge of a stream, for evaluating currently observed discharges, because it represents a discharge that is just as likely to be exceeded as not.

The terms "daily mean" and "mean daily" should not be used indiscriminately, nor should "monthly mean" and "mean monthly," "annual mean" and "mean annual," etc. The daily mean discharge for any day is defined as the mean discharge for that one day; the mean daily discharge for any one day, October 10, for instance, is the arithmetic mean of the discharge on all October 10's of record, or during a specific period of years. Likewise, the monthly mean discharge for October 1951 is simply the arithmetic mean of the 31 individual daily mean discharges during that month, whereas the mean monthly discharge for October is the arithmetic mean of all October means of record or during a specific period of years. In Survey reports the term "daily discharge" is used to describe the daily mean discharge, and the terms "monthly discharge" and "yearly discharge" are used similarly. Inasmuch as there will be but a few occasions when the term "mean daily discharge" will be appropriate, Survey authors should use the word "mean" only when it is necessary to define the thought adequately, and even then perhaps the word "average" would be more appropriate in many places. However, in writing of temperature, "mean" will be needed more frequently for consistency with the usage of the Weather Bureau, and the distinction between "daily mean" and "mean daily" described above should be maintained.

The term "average discharge" as used by the Geological Survey is defined as the arithmetic mean of all yearly discharges of record or for any specified period of years. It is not a true mean, as no extra weight is given to years having 366 days; however, the error introduced is so small that it can be ignored. A yearly mean discharge is a true arithmetic mean, as it is the sum of all the daily mean discharges divided by the number of days in that year.

The terms "flow," "discharge," "streamflow," and "runoff" have been used rather loosely, and sometimes indiscriminately, in Survey reports and in hydrologic literature in general. It seems desirable to define these words for Survey use so that each will carry a distinctive

meaning. The following definitions are suggested, in order from the most abstract to the most concrete:

"Flow" means fluid motion and is the most general of all the terms. It can be used appropriately to describe the motion of liquids and gases under any conditions, in a canal or pipe, on the land surface, or below the surface.

"Discharge" means outflow. The use of this term is not restricted as to course or location, and it can be applied to describe the flow of water from a pipe, from an aquifer, from a lake, or from a drainage basin. If the discharge occurs in some course or channel, it is proper to speak of the discharge of a canal, of a river, or of a well. It is proper also to speak of the discharge of a canal or stream into a lake, a stream, or the ocean.

"Streamflow" is the discharge that occurs in a natural stream course. Although the term "discharge" can be applied to the flow of a canal or an aquifer, the word "streamflow" uniquely describes the discharge in a surface stream course.

"Runoff" is the part of the precipitation that appears in surface streams that are not regulated. Accordingly, it is the streamflow unaffected by artificial diversions, storage, and other works of man in or on the stream channels. Works of man undertaken within the drainage basin but not in or on the channels, such as land-management practices, may affect the amount of runoff from a given amount of precipitation, but the runoff is still equivalent to streamflow. Runoff is not equivalent to streamflow where the artificial works are in or on the channel; thus the distinction between streamflow and runoff depends on channel factors and not land factors. Streamflow data can be adjusted to compute runoff by incorporating adjustments for storage and diversions. Because these computations depend on interpretation and judgment, the term "runoff" should be reserved for use in reports in which there is opportunity to explain the nature of the adjustments, if any are required. In reports listing basic data exclusively the general term "discharge" or "streamflow" is more appropriate.

"Water yield" is runoff from a basin, including ground-water outflow that appears in the stream, plus ground-water outflow that bypasses the gaging station and leaves the basin underground.

Any of these terms can be expressed in units of rate or of volume. Thus the daily discharge of a river can be expressed as so many cubic feet per second, and the annual discharge as so many cubic feet per second or so many acre-feet.

The term "runoff" has come to be expressed chiefly in units of volume, or in units of depth averaged over the entire drainage basin. Thus the runoff in a given period or during a given flood is reported as

so many acre-feet, or so many inches of depth. The term "rate of runoff" may be used when a unit of rate such as cubic feet per second, inches per hour, or cubic feet per second per square mile is employed.

The data in reports on surface water represent the total fluids measured. Thus the terms "discharge," "streamflow," and "runoff" necessarily represent the sediment-water mixtures measured at gaging stations, unless specifically designated otherwise.

In reports on waterpower potentials it is important to adhere to the meaning and usage of the above terms. Rates and quantities of power available also must be described uniformly and precisely. The glossary of power and rate terms prepared in 1949 by a subcommittee of the Federal Interagency River Basin Committee contains the most precise and widely accepted definitions of power terms yet assembled. According to that glossary, "adverse water conditions" are conditions limiting production of hydroelectric power, either because of low water supply or of reduced gross head. "Capability" is the maximum load a machine, plant, or system can carry for a given time under specific conditions. "Capacity," unless qualified, means rated capacity of a machine, plant, or system. "Drawdown" refers to the distance the water surface of a reservoir is lowered below the maximum elevation, by withdrawal of water. "Dump energy" is energy produced from water that cannot be stored and is beyond the immediate needs of the system.

Care should be taken in referring to head for waterpower production. "Total head" should be used if the total fall of a stream, or fall in a given reach of a stream, is intended. "Gross head" refers to the difference in elevation between water surfaces of forebay and tailrace of a powerplant. "Net head" is gross head less all hydraulic losses except those chargeable to the turbine.

The American Standards Association defines "load factor" as the ratio of the average load over a designated period to the peak load occurring in that period. "Plant factor" is defined as the ratio of the average load in the plant during the period considered to the aggregate rating of all equipment installed in the plant. Power that is available continuously is referred to as "primary power." "Firm power" need not be available continuously but must be available to the customer to meet his load requirements—for example, available during working hours or during the evening hours. All hydroelectric power other than primary power is properly termed "secondary power."

"Total theoretical potential waterpower," in horsepower at the turbine shaft (assuming no conveyance losses and 100-percent efficiency), is the weight of a cubic foot of water (62.4 pounds) times the discharge (Q), in cubic feet per second, times the total head (H), in

feet, divided by the equivalent of 1 horsepower (550 foot-pounds per second)—

$$\text{Horsepower}=\frac{62.4QH}{550}=\frac{QH}{8.81}=0.1135QH$$

The output in kilowatts, based on 100-percent overall system efficiency, is $0.0847QH$. This formula was used to compute the potential waterpower of the world as listed in Geological Survey Circular 367. Most computations by the Geological Survey of potential waterpower for sites in the United States are made on the basis of static head and an assumed overall efficiency of 80 percent ($kw=0.068QH$). Potential power from proposed variable-head reservoirs is computed on the basis of average static head.

"Total theoretical potential power," although never attainable, has an important place in waterpower analysis because it can be computed for all sites, streams, basins, or regions on a fairly uniform basis. "Technically feasible," sometimes called "physically feasible," waterpower potential represents a degree of potentiality somewhat less than the total. Although it is not so easily determinable as is gross (total theoretical) potential, it nevertheless can be determined upon a fairly uniform basis for different sites, streams, basins, or regions. Estimates of potential waterpower approximating the technical limits can be computed by using the average streamflow and the total head available.

"Economically feasible waterpower potential" is the portion of available power potential that can be developed in competition with other forms of power. The economic feasibility of an individual site can be determined only at the time a detailed investigation is made. Circumstances changing with the passing of time may change considerations of economic feasibility, and projects that are not practical today may be entirely justifiable in the future. Waterpower investigations made by the Geological Survey seldom enter deeply into consideration of economic feasibility, usually being concerned primarily with the total capabilities of sites, streams, or regions.

QUALITY-OF-WATER REPORTS

Quality-of-water information normally appears in three types of reports: compilations of basic data, reports describing ground-water or surface-water resources, and comprehensive interpretive reports devoted principally to specific quality-of-water problems. The three types have one basic requirement: tabulations of data must be accurate and as nearly uniform and consistent as possible. Uniformity facilitates review and publication of the results, simplifies interpretation by those engaged in water-quality investigations, and assures the reader that basic data in reports on different areas are comparable.

Continuing emphasis is being given to uniformity in table headings and in units for reporting data. The water analyst may consider it unnecessary to express hardness of water in "parts per million as $CaCO_3$" or the specific weight of deposited sediment in "pounds per cubic foot," but omission of such information creates one of the principal problems in reporting data on quality of water. For this reason, specific instructions on expression of results have been issued for the preparation of the annual compilation entitled "Quality of Surface Water of the United States." That report includes the chemical analyses and temperature and suspended-sediment determinations of surface water made by the Geological Survey during a water year.

There is increasing use of non-Survey data in comprehensive reports on quality of water, particularly in reports that evaluate the availability and usability of water. Recent data on dissolved oxygen, biochemical oxygen demand, and trace elements may be available from investigations of sanitary quality made by other agencies, and the inclusion of these data may contribute substantially to the value of the reports. Often older data, generally in the form of incomplete chemical analyses of water, will be available from industrial and consulting laboratories or from governmental agencies. Whether these data should be included in the Survey's report will depend to a large extent on their accuracy and the use that is to be made of them. For example, an author attempting to correlate the amount of iron in the water with the geologic units in which the water occurs or through which it has moved will find it necessary to know the techniques used in the determination of iron—whether the figure represents iron in solution, colloidal iron, or iron in suspension, and whether part of the iron is present in the suspended materials in a turbid sample or is caused by corrosion of pipes, well casing, or other equipment.

As in other Survey reports, illustrations facilitate the reader's comprehension of the data. Also they are helpful to the author during preparation of the report, by showing the areal distribution of ions or other physical or chemical properties of the water. Illustrations are most effective if they are referred to frequently in the text.

Simple diagrams that illustrate one relation or condition are preferred. Bar diagrams have wide application in depicting chemical data. Some authors prepare these on a logarithmic scale, because a great range in concentration can be depicted, but this method may create an erroneous picture unless the reader is told that it exaggerates the lower values. In many diagrams, plotting on ordinary arithmetic scale, the vertical scale being broken to show multiples, will serve the same purpose.

Hydrographs relating concentration of chemical constituents, sediment content, or temperature to streamflow have wide application.

Discussion of the significance of troughs and peaks in the curves and of the relation between the quality of base flow (largely ground-water discharge) and that of direct runoff may add materially to the value of a report.

Where sufficient continuous records are available, curves showing such features as duration or frequency of given concentrations may assist in establishing relations that are useful in studies of withdrawal or diversion of surface water by municipalities, industries, powerplants, or irrigators.

In a comprehensive study on surface water, the data on quality of water generally are obtained by means of daily sampling at stations for which long-term records, together with periodic or infrequent observations, provide a fairly accurate indication of changes in quality. For streams subject to flash floods, such as those in arid or semiarid regions, weighted averages for a continuous period of sampling are obtained by weighting each constituent in a single or composite analysis in accordance with the mean water discharge for that day or period. For streams in which there is little fluctuation in concentration of individual constituents, arithmetic rather than time-weighted averages of the constituents may give satisfactory results; but the time-weighted average should always be used if the composite samples cover periods of various length. Water-Supply Papers 1186 and 1187 illustrate the different types of records and averages used in computations.

"Arithmetic mean" and "median," two kinds of averages that are in common use to describe groups of data, are sometimes used incorrectly. The median differs from the mean in that it is the value of the middle item when the items are arranged according to rank. (See p. 43–44.) The median is frequently used in statistical treatment of data on quality of water, particularly for large groups of data on ground water. It has been found useful also in describing the particle-size distribution of sediments. The usefulness of median values is determined largely by the distribution of the observed data; for example, the clustering of plotted points at the lower end of a distribution curve may give a median that is much lower than the arithmetic mean. The principal advantage of the median lies in its independence of unusual values. Geological Survey Water-Supply Paper 1373 illustrates the use of the median in sedimentation studies.

A source of some confusion in reports on quality of water is the lack of standardization of terms, particularly those used in describing the amounts of dissolved or suspended solids. "Concentration of dissolved solids," "mineral content," and "salinity" are frequently used in the same report, in which the author may unintentionally imply a distinction. Actually, in Survey practice the terms are synonymous;

each refers to the reported quantity of dissolved solids—either the residue on evaporation, dried at 180°C, or, for many waters that contain more than about 1,000 parts per million, the sum of determined constituents. To avoid confusion, the use of "dissolved solids" or "dissolved-solids content" to express concentration is preferred.

"Saline" normally refers to water having a high concentration of dissolved solids. Sodium chloride may be the principal salt, as in ground water affected by sea-water encroachment or in highly mineralized connate water. However, in arid or semiarid regions saline water may contain principally sodium sulfate or calcium sulfate, or may be a solution of several compounds. No sharp distinction is made in Survey reports as to either the type or the threshold of concentration of dissolved solids in water referred to as saline. Because of the active research on processes of demineralizing saline water that began about 1950, a need arose for a more general understanding as to a threshold value above which water might be considered saline, and the term has been considered by many to mean water containing more than 1,000 parts per million of dissolved solids. No distinction is made as to the composition of the dissolved solids.

"Hardness" of water in the Survey analysis is defined as the property of water attributable to the presence of alkaline earths and is expressed as equivalent calcium carbonate ($CaCO_3$). The recently developed ethylenediamine tetraacetic acid method for determining hardness and calcium by direct titration is being used almost exclusively in routine water analysis. This technique supplants the older, less accurate soap-hardness method. Hardness is a physical-chemical characteristic, not a substance; therefore it should be referred to as "hardness of water," not "hardness in water" or "concentration of hardness" or "parts per million of hardness."

Authors sometimes have difficulty in relating data for pH, alkalinity, and acidity. By definition the pH of a solution is the negative logarithm of the concentration of hydrogen ions. As usually determined, by means of a line-operated pH meter, it measures the activity of the hydrogen ions and thus is a numerical value or measure of the alkalinity or acidity of the water. However, a water that is acid, alkaline, or neutral according to the pH scale is not necessarily the same by another standard. For this reason, when referring to the alkalinity or acidity of water, pH is the preferred term rather than hydrogen-ion concentration expressed by weight.

Ordinarily, water having a pH of 7.0 is regarded as neutral; a pH lower than 7.0 indicates acidic properties, and a pH higher than 7.0 indicates alkalinity. However, there is an interrelation among acidity, alkalinity, and free carbon dioxide in water. Free carbon dioxide lowers the pH, but carbon dioxide combined as bicarbonate

in solution raises the pH. Theoretically, bicarbonate may be present in water over a pH range from more than 12 to less than 4; however, a lower limit of about 4.5 is accepted in Survey laboratories for practical purposes in titration. As bicarbonate and carbonate are associated with alkalinity, it is evident that water containing bicarbonate would show an alkaline reaction in a solution having a pH as low as 4.5, whereas, on the basis of pH alone, water having a pH lower than 7 would be considered acid. The Geological Survey avoids this complex problem by reporting the concentrations of individual ions, such as carbonate and bicarbonate, rather than alkalinity. Water containing free mineral acids, such as sulfuric, hydrochloric, or nitric, has a pH less than 4.5.

The field of stream-sedimentation investigations is comparatively new, and because its terminology is in a state of flux some misuse of terms has appeared in publications. For example, following a common lay usage, some authors have used the term "silt" in referring to sediment. Because silt is only one of the several size fractions of sediment (clay, silt, sand, etc.), it is erroneous to refer to sediment as silt unless reference is made to that size fraction only.

REPORTS ON MINING DISTRICTS

Reports on mining districts vary widely in scope. Their forms of publication differ accordingly, ranging from the book reports with many illustrations to the various geologic map series with or without text. The most comprehensive reports, which ordinarily are those that deal with large extensively developed districts, may be published either as professional papers or as bulletins; the choice often depends upon the size and complexity of the illustrations. The shorter reports may deal with districts that are small or only slightly developed or that do not involve complex problems, or with certain special features or aspects of the district concerned.

Breaking up a potentially lengthy report into a series of shorter reports may have several advantages. The shorter reports afford easier reference, are more convenient and less costly to the public, and require less time for publication. They may be more widely read. When a long report is divided, some overlapping of material among the parts inevitably results; but if the partitioning is carefully planned so that the interrelationship of the various topics is plain and the repetition kept to a minimum, the quality of the report as a whole need not be affected. A potentially short report should never be expanded beyond the limits justified by the relevant information to be presented.

Before beginning to write—indeed, before beginning his fieldwork—an author should be sure that he is thoroughly familiar with the

literature on the area or subject he is going to discuss. In his report he should demonstrate that he has made real use of this literature, not just by listing references but by giving evidence throughout his discussions that, although he has made his own investigation, has done his own interpreting of data, and has drawn his own conclusions, he continually has been aware of the findings of others. Just how much is the author's contribution and how much has been contributed by earlier workers should be made plain, and the author must not fail to acknowledge the source of any specific facts or interpretations that he has used. Special care should be taken to acknowledge maps, production figures, or other data obtained from colleagues or from outside sources.

Unpublished mine-production data supplied to the author by the U. S. Bureau of Mines should not be included in a report unless the Bureau of Mines has certified that the mine owner has granted permission for publication, or unless the mine owner has given the author written permission to publish the data. Such tabulated data should have the following heading: "Compiled by the U. S. Bureau of Mines and published with permission of the owner(s)." Some mine owners furnish the author their own compilation of mine-production data, and if these data are to be published, written permission should be obtained from the owner and a proper credit line used.

ORGANIZATION OF MATERIAL

The main purpose of many reports on mining districts is economic, and in these reports the discussion should be organized and the data presented so that the reader's attention is focused on features that may be of value in the economic development of the district described. The relative emphasis to be given individual topics cannot be standardized, however. Mineral deposits themselves differ so much that the author must evaluate the importance of each topic in describing each deposit. Stratigraphy, for example, should be stressed in reports on bedded deposits and on epigenetic deposits that were stratigraphically controlled, whereas the stratigraphy of rocks younger than the mineral deposits may be dealt with briefly unless it is of significance to the exploitation of the deposits.

In deciding on the best way to arrange and present his material, an author will find it helpful to analyze and weigh the effectiveness of the plans of organization used in published reports that describe similar deposits.

An introductory general statement of the content of the body of the report should prepare the reader for the detailed descriptions that follow and for the trend of the ensuing discussion. In any section whose subject involves intricate problems—such as those of com-

plex structure—the author can save space and command the reader's attention by beginning the discussion with a statement that summarizes his conclusions on the subject. By this means, as soon as evidence is presented its bearing on the conclusions will be apparent; it will thereby eliminate all danger of mystifying the reader as to where the discussion is leading or as to why the author is assailing him with a mass of seemingly unrelated facts.

Distinguishing between processes and the results of processes is essential. Terms such as "metallization," "replacement," "alteration," "silicification," and "impregnation" generally should be restricted to processes rather than products, although some—"wallrock alteration" for example—are hallowed by long-continued use. Phrases such as "zone of silicified rock" rather than "zone of silicification" should be used in referring to the results of processes. Indiscriminate use of the same term for process and product can result in confusion: "zone of weathered rock," for example, may or may not be the same as "zone of weathering." Typical examples of the misuse of such terms are "mineralization can be seen in all the openings" and "these deposits are tabular quartzose replacements." Distinction should always be made between the mineral deposit as a whole and the ore shoots within it; similar distinction should be made between ore shoots and stopes.

The term "secondary enrichment" is strictly tautologic because enrichment is by definition a secondary process. The author may prefer the term, if it has become firmly established in local usage; but it is better to use "supergene enrichment" or "hypogene enrichment," whichever is appropriate.

DEFINITIONS

It is not possible, of course, to discuss a technical subject without using some technical terms. Terms that have been generally accepted or that are used consistently in standard textbooks are appropriate in reports on mining districts; but because many readers—especially those interested in the descriptions of mines—will not be familiar with all the nomenclature of geology, the technical terms that may be misunderstood ought to be defined. Especially in need of definition are technical terms that do not have the same meaning in all regions. As a rule, Survey reports should adhere to general rather than local usage, unless such usage interferes seriously with clarity or conciseness.

The usage of certain common terms should be standardized insofar as possible, although it is difficult to formulate universally acceptable definitions for some of them. Much discussion has been published on the term "ore," for example, but no single definition proposed has

been entirely satisfactory—partly because the materials to which the term is generally applied are so diverse that attempts at a strict definition involve quibbling over minor details. Most definitions stipulate that "ore" is a mineral or a rock from which one or more metals can be extracted profitably, but not all the provisions of this stipulation can be applied in many situations, of which three are mentioned here: (a) some extraction processes yield only compounds of metals rather than the metals as such; (b) rocks or minerals from which valuable nonmetallic substances can be recovered profitably are considered ore by many geologists; and (c) a considerable amount of material recovered from so-called ore is unprofitably produced although it enters the market. These examples emphasize the futility of an attempt at strict definition of the term. Such related terms as "mill ore," "protore," and "metallized (or mineralized) rock" will help in descriptions. The term "gangue" should generally be restricted to valueless minerals associated with valuable minerals. Clear descriptions will avoid confusing usage of the term. Because in many ore deposits certain metallic minerals such as pyrite have no current economic value locally, some authors will prefer to call them "gangue" in relation to these deposits; but generally it is better to refer to them as "associated metallic minerals."

TOPICS FOR DISCUSSION

In the more comprehensive reports on mining districts the following topics require discussion: geography, geology, mineral (or ore) deposits, and mines and prospects. In addition, the main body of every report—whatever the scope of the study—begins with an introductory section.

In some reports the discussion of each of the topics mentioned in the preceding paragraph may constitute a major division of the report. In others, if the information on a given topic is scanty or has been published previously, it may be desirable to discuss the subject in conjunction with one of the others under a single broader heading, or to include in the introduction a brief statement summing up the matter. If the pertinent material is both voluminous and especially significant, one of these topics may be subdivided and each part of it treated as a main division of the report. A choice among the methods of treatment possible in this respect will be determined by the amount, complexity, and importance of the information to be presented.

INTRODUCTION

In most major reports the introduction should begin with a brief statement of the location and importance of the district investigated. The section should include a statement of the purpose of the investiga-

tion, an acknowledgment of cooperation and favors, and a summary of previous work in the same field. In some districts the previous work may have been so extensive and its pertinent literature so voluminous that a briefly annotated selected bibliography in the introduction is desirable.

GEOGRAPHY

The attention that should be given to geography depends upon the district studied, but it should be brief for most areas in the United States. If the area is little known a discussion of climate, vegetation, and topography is relevant insofar as these features bear on local mining conditions, and is desirable unless the subjects have been adequately treated in some previous publication. Discussions of the accessibility of the region should be limited in most reports to local problems and transportation facilities. Information concerning current regional transportation is generally available from other sources. Because topographic features are the latest results of geologic processes, their origin generally should not be treated until the geologic features have been described.

GEOLOGY

In the section on geology there should be a discussion of the rocks, the structure, and the geomorphology of the district; and generally a summary of the geologic history of the region should conclude the section. Detailed discussion of the ore and its geologic relations should be reserved for the section on mineral deposits.

The rocks should be dealt with in the order of their age, from oldest to youngest; they generally should not be segregated according to origin—that is, igneous rocks together, sedimentary rocks together, and metamorphic rocks together. The distribution, character, and composition of the original and altered facies of the different formations should be described, in addition to their economic aspects. The author should include petrographic descriptions that are essential to the purpose of his paper or are geologically or economically significant, but should avoid those that are unnecessary or overdetailed. Detail is desirable, of course, when it contributes to some conclusion, or when something rare is described. However, an author should not think that because he has examined thin sections of all the rocks of a district it is necessary to publish exhaustive descriptions of them all down to the last accessory mineral or the slightest textural variation of the most ordinary rock. Actually, petrologic data are needed in the discussion rather than a type of petrographic catalog.

The descriptions of the rocks should be followed by a discussion of geologic structure in which the author interprets the origin of the different structural features insofar as information permits. He may

point out briefly the extent to which structure has controlled the distribution and form of intrusive igneous masses and the courses of ore-forming fluids, but should reserve his complete treatment of structural control for the section on mineral deposits.

The interpretation of topographic features should come next. Some aspects of geomorphology may be exceedingly important where the ore consists of placer deposits or of products of weathering or supergene enrichment. In reports on such areas or districts, the author should relate the development of present topography to the accumulation of ore or to processes of enrichment or noteworthy effects of ground-water movement. If ore deposits are localized along old channels, terraces, or other features of a former topography now buried beneath Tertiary or even older rocks, the development of the old erosion surface deserves consideration, either in conjunction with the discussion of geomorphology or as a separate topic. The auriferous channels of California and the transported bauxite deposits of Arkansas are examples of such deposits.

MINERAL DEPOSITS

The section on mineral deposits should present such historical and descriptive data as will help mine operators to understand and evaluate those factors that ought to be considered in planning development and exploration. The pertinent subjects generally should be treated in this order: history and production; mineralogy; general character and classification of the deposits, followed by a description of each class; genesis of original deposits; processes of alteration and enrichment; and practical applications. This sequence can be changed if the organization is improved thereby.

When one of the older or larger mining districts is studied, the history of its discovery, its mining and cultural development, and its production should be summarized—generally as part of the section on mineral deposits. The author should make every effort to separate truth from legend in the historical material he has assembled and to use only facts in his discussion. In reports on districts of especial interest, the amount of accurate information that has a significant relation to the subject will determine to some extent the length of the section on history; in reports on small districts, however, the information may be so scanty that it is most conveniently included in the general introduction. The review of production should cite the geologic, technologic, and economic conditions that have accounted for changes in the rate of production and should conclude by calling attention to information in subsequent sections that may have a bearing on future production and development.

Although mineralogy must be discussed, not all reports need have a separate section devoted to it. Because its chief significance is the relation of minerals to the problems of ore deposition, enrichment, oxidation, wallrock alteration, and the like, mineralogy in some reports may preferably be treated under those topics rather than separately. However the discussion of mineralogy be handled, it should usually be limited to the ore minerals and those minerals associated with them that are significant in the economic or petrologic problems considered, although other minerals of special interest to mineralogists may be described. Discussion of features that will affect the processes of mineral recovery may be included. Mere listing of minerals, especially insignificant ones, should be avoided. If in the longer and more comprehensive book publications the subject of mineralogy is taken up in a separate section, this section should precede the discussion of the general character and classification of deposits, because the mineralogy is at least a part of the basis for the classification. The section should end with a summary of paragenesis, which may be mostly a review of pertinent parts of the preceding descriptions and which should serve as a basis for any discussion of the classification, origin, and zoning of ore deposits.

A discussion of the general character of the deposits should lead into the presentation of any scheme of classification that the author may have devised for convenience or clarity. Much has been written about the classification of mineral deposits, and most writers favor a genetic classification when considering mineral deposits in general; but as a mining district may contain deposits that fall within 2 or 3 subdivisions of such a classification (although they differ markedly in form, structure, and mineral composition) a further subdivision based on these differences may be desirable.

Detailed descriptions of the several classes and subclasses of mineral deposits should follow, in the sequence in which they appear in the plan of classification. The description of each category should include an account of the distribution of the main deposits of that type and the ore shoots in them; the controlling geologic features; the structural relations; the processes of ore deposition or concentration; and, if appropriate, related alteration or replacement of wall rock.

If investigations of the altered rock have yielded essential data on the history of mineralization or have disclosed valuable guides to ore, the altered rock and the processes of alteration are entitled to emphasis comparable with that accorded the ore bodies; if the altered rock in contact with veins is itself the ore, the altered rock and the processes of alteration may properly be discussed in greater detail than the veins. Whether the discussion of wallrock and its alteration is to constitute a separate section or a part of the general section on mineral

deposits should be determined by its relative length and importance. A section on alteration—whether the alteration was effected by hydrothermal or contact-metamorphic action or by weathering—may follow the treatment of the rocks that have been altered, or may be more closely associated with the discussion of mineral deposition.

The section on practical applications should be the final section of the general part of the report. In it the author should point out how his work may aid in the development of ore bodies and in the finding of new ones, and should express his conclusions regarding mineral resources and the economic future of the district as a whole. Estimates of a district's potentialities for future production may contribute substantially to the value of a report. A part of this appraisal may be a statement on estimated reserves of mineral resources. The various categories of estimated reserves and the use of such data in Geological Survey reports are discussed on pages 58–60.

DESCRIPTIONS OF MINES AND PROSPECTS

The descriptions of mines and prospects serve as a means of preserving valuable geologic records, and the importance of their preparation should not be underestimated. The descriptions should be detailed; they should contain as full and accurate information as is available on the discovery, development, production, and geologic features of each mine; and they should be adequately illustrated. The general reader may have little interest in these detailed descriptions, but mine operators and others who may become interested in a mine even many years after the report is published will refer to them for information and may value such descriptions more than the general part of the report. The more nearly complete the descriptions, the better the author's basis for his general conclusions; in fact, it is advisable to prepare rough drafts of the mine descriptions before completing the general sections of the report, because this practice gives a strong appreciation of the relations between ore deposits and various geologic features and prepares the author for emphasizing these features throughout the report. Care should be taken that data of general interest, which properly belong elsewhere, are not "buried" in the mine descriptions. Such data should be thoroughly discussed in the appropriate section or sections of the general part of the report, but may be mentioned again in the mine descriptions if desirable.

MINERAL RESERVES AND POTENTIAL RESOURCES

Discussion of mineral reserves and potential resources is presented in many Survey reports, and it forms an important part of the author's appraisal of the district or area under study for future mineral production. Estimates of reserves should be in harmony with accepted definitions of the different classes of reserves, and the figures pre-

sented should be within the appropriate limits of significant figures (p. 99). The grade of the estimated reserves should be stated in percentage or in accepted physical units, not in monetary value. Summary and detailed estimates by the author may be presented for a district or area if such presentation of the data on maps, in tables, and elsewhere does not disclose the reserves of an individual property. Published estimates for individual properties may be cited provided endorsement of the figures by the Survey is neither stated nor implied.

METALS AND MINERALS (EXCEPT FUELS)

The definitions of the different classes of reserves of metals and minerals (except fuels), as agreed to by the Geological Survey and the Bureau of Mines in April 1943 and used since then in all Survey and joint Survey-Bureau reports, are as follows:

Measured ore is ore for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill holes and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are so closely spaced and the geologic character is so well defined that the size, shape, and mineral content are well established. The computed tonnage and grade are judged to be accurate within limits which are stated, and no such limit is judged to differ from the computed tonnage or grade by more than 20 percent.

Indicated ore is ore for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to outline the ore completely or to establish its grade throughout.

Inferred ore is ore for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred ore should include a statement of the spacial limits within which the inferred ore may lie.

Realistic appraisal of a district or area must consider **total resources,** of which **reserves** are only a part. The distinctions between **reserves** and **potential future sources** have been outlined by the Geological Survey and Bureau of Mines (President's Materials Policy Commission, 1952) as follows:

* * * the term **"mineral reserves"** refers only to the material that in some degree has been inventoried in terms of commercial enterprise * * * [and] can be mined, processed, and marketed without financial loss under the economic and technologic conditions prevailing at the time of the inquiry. * * * It does not contain material of submarginal grade which, with improved economic conditions, may become a reserve, nor does it include off-quality material which cannot be treated satisfactorily under current technologic practices. * * *

The use of materials classed as "marginal" and "submarginal" primarily awaits more favorable prices, whereas utilization of most of the material classed as

"potential future sources" must await new—in some cases revolutionary—technologies as well. * * * It is recognized, however, that in certain instances these materials contain some of the greatest potentialities for future sources of supply even though they cannot be tapped economically by existing mining and metallurgical methods.

Authors should, accordingly, be careful to distinguish insofar as possible between **reserves** and **potential resources.**

CRUDE OIL, NATURAL GAS LIQUIDS, AND NATURAL GAS

The definitions of the proved reserves of crude oil, natural gas liquids, and natural gas as used by the American Petroleum Institute and the American Gas Association (1957) and as accepted by the Geological Survey are summarized as follows:

The **proved reserves** of crude oil, natural gas liquids, and natural gas are the quantities known or reasonably assured to be recoverable under existing economic and operating conditions, based both on the amount of drilling and on the existing knowledge of the geologic, engineering, and reservoir data. Crude oil and natural gas include those liquid hydrocarbons and gases not placed in the category of natural gas liquids. Natural gas liquids are those hydrocarbon liquids which are gaseous or in solution with crude oil in the reservoir and which are recoverable as liquids by the processes of condensation or absorption which take place in field separators, scrubbers, gasoline plants, or cycling plants. Natural gasoline, condensate, and liquefied petroleum gases fall in this category.

To designate total reserves or undiscovered reserves, authors have used many adjectival terms such as "potential," "potentially recoverable," "ultimate," "potential ultimate," "possible," and "discoverable." For these categories of reserves authors should choose and define their terms carefully.

COAL

In calculating coal reserves, separate categories must be established according to the rank of the coal, the thickness of the beds, the thickness of overburden, and the relative abundance and reliability of the available information.

Where coal of more than one rank is covered by an individual report, the data on reserves are reported separately for each rank and, if feasible, for each subrank, according to standard specifications of the American Society for Testing Materials (1954) for the classification of coals.

The standard thickness categories used in calculating coal reserves differ according to the rank of the coal, as follows:

Rank	Thickness categories		
Anthracite, semianthracite, and bituminous coal inches	14–28	28–42	>42
Subbituminous coal and lignite feet	2.5–5	5–10	>10

The most widely used and recommended overburden categories are as follows:

	Overburden categories (in feet)		
Strippable coal	<60	60–90	90–120
Underground mined coal	<1, 000	1, 000–2, 000	2, 000–3, 000

The standard reserve categories of the Geological Survey and the Bureau of Mines as adopted for use in calculating reserves of coal are summarized as follows:

Measured reserves of coal are reserves for which tonnage is computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced, and the thickness and extent of the coal are so well defined, that the computed tonnage is judged to be accurate within 20 percent or less of the true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of coal varies in different regions according to the character of the coal beds, the points of observation are, in general, not greater than half a mile apart.

Indicated reserves of coal are reserves for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are approximately one mile apart, but they may be as much as one and a half miles apart for beds of known geologic continuity.

Inferred reserves of coal are reserves for which quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and for which few measurements of bed thickness are available. The estimates are based on an assumed continuity for which there is geologic evidence. In general, inferred coal lies more than two miles from the outcrop or from points of mining or drill-hole information.

OIL SHALE

As oil-shale deposits are not (in 1957) developed commercially in the United States, the potentially useful contents of such deposits may be classed as **potential reserves.** Estimates of tonnage and oil content of a deposit may be designated as **measured, indicated,** or **inferred** to correspond with Survey standards of accuracy for ore reserves. The estimates should be accompanied by statements of the assumed limits and methods of projecting data beyond points of observation or measurement; of the minimum oil content and methods of determining oil content; of the assumed limits of bed thickness, overburden, and distance from outcrop; and of other geologic factors that would affect utilization of the deposits. The size of deposits should be expressed as tons of oil shale in the ground. The oil content, or potential oil yield, should be expressed in gallons of oil per ton, and also in percentage of oil, or barrels (42 gallons) per unit area.

Statements of potentially recoverable oil in the deposits should be attributed to a responsible technical source.

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President's Materials Policy Commission, 1952, The outlook for key commodities, *in* Resources for freedom: v. 2, p. 136–137.

PETROLOGIC TERMINOLOGY

Petrographic descriptions are an essential part of many geologic reports. However, such descriptions are not easy reading at best and demand great care to keep them as free as possible from highly involved terms. The geologist who includes petrographic descriptions in a geologic report should make them an essential part of the story he has to tell.

Petrology, more than most sciences, has been plagued by a formidable jargon of its own. More than 1,000 rock names are said to be in current usage to some extent. Most specialists in petrology understand the meaning of only a fraction of these. Henry S. Washington, who himself had proposed 31 new rock names, spoke of the host of new names as "impossible to remember and not worth remembering." He once remarked also that he was spending his later years in sackcloth and ashes over his early rock-naming sins, and then related a story about himself. He told of receiving a paper from England that contained a rock name meaningless to him. He asked Norman L. Bowen if he knew what the Englishman was talking about, and Bowen replied, "You should know, you proposed that name yourself." Washington added, "Do you know, I had to hunt up and read that old paper myself to find out what it was all about."

The widely accepted alternative to this confusing heterogeneity of names is the use of well-known modifiers. Thus, Prof. Arthur Holmes (1920, p. 4–5) has said—

> More purely descriptive names, formed by adding mineral-prefixes to existing rock-names, such as biotite-hornblende-granite, are self-explanatory * * *. There is much to be said in favor of combinations of these kinds, as they reduce the number of fundamental names to be remembered * * *.
>
> * * * In a case like this I consider that three words are better than one. Brevity of expression is by no means an unmixed blessing, and the one word may require a whole paragraph of explanation.

The Geological Survey has adopted a uniform scheme for the use of hyphens in petrographic terms, based on the single principle that like names are connected by a hyphen and unlike names are not. The names used in such terms are of four classes—(a) rock names, (b) mineral names, (c) textural names, such as porphyry, gneiss, or vitrophyre, and (d) names expressing the kind of clastic aggregation, such as agglomerate, breccia, or tuff. Any two or more names of the same class are connected by a hyphen; others are not. To avoid confusion, a compound term that, according to this principle, is not hyphenated should remain without the hyphen when it becomes a unit modifier preceding some other word—for example, "quartz monzonite dike." In general, it is better to insert textural terms such as those under (c) as adjectival modifiers, as illustrated below. The following examples illustrate the method:

Biotite-pyroxene andesite
Albite-epidote-chlorite schist
Nepheline syenite porphyry (porphyritic nepheline syenite is preferable)
Trachyte tuff

Expressions like "granite-syenite contact" seem to refer to a single rock; it is preferable to write "contact of the granite and syenite."

Some rock names that have come into general use may, if desirable, be followed by an explanatory term in parentheses—for example, "norite (hypersthene gabbro)."

Certain adjectives are commonly worse examples of polysyllabic jargon than rock names, and many are needless. Simple English expressions can be substituted for many of these, with added clearness and readability. For instance, "aphanitic" (fine-grained), "melanocratic" (dark-colored), "leucocratic" (light-colored); "hololeucocratic" or "holomelanocratic" are still worse. The shorter, more euphonious terms "euhedral," "subhedral," and "anhedral" are preferable to "idiomorphic," "hypidiomorphic," and "allotriomorphic."

The use of "acid," "basic," and "alkaline" in describing rocks and minerals has been frowned upon since the time of F. W. Clarke. These terms should not be used to describe rocks or such minerals as the feldspars. Rocks are "silicic" if characterized by quartz. Rocks and feldspars are "alkalic," "calcic," "sodic," or "potassic," never "alkaline." Light-colored minerals such as quartz, feldspars, and feldspathoids are called "felsic" minerals when reference is made to the mode, and "salic" minerals when reference is made to the CIPW (Cross, Iddings, Pirsson, and Washington) norm classification. "Basic" is objectionable for rocks; "mafic" and "ferromagnesian" are preferred. The dark minerals of these rocks are called "mafic" minerals when reference is made to the mode, and "femic" when reference is made to the CIPW norm classification. The use of "ultra-

basic" cannot always be avoided, but where "ultramafic" is appropriate it may be used instead.

Rocks generally are named on the basis of mineral composition and so a shift to a textural name is objectionable. Thus "porphyry" should be avoided so far as possible and the rock described as "porphyritic" (porphyritic granite). However, the term "porphyry" has become so firmly fixed for certain types of hypabyssal (moderate depth) rocks that it cannot be entirely avoided; abyssal and extrusive rocks should never be called porphyries but described as porphyritic if characterized by phenocrysts.

The term "clay" is used for both the finest size fraction of sedimentary deposits and a group of minerals having characteristic physical and chemical properties. In petrographic descriptions use of the term as a size designation should be avoided wherever possible. Such use in describing sediments and sedimentary rocks cannot be avoided, but ambiguity in use should be avoided.

The grade-size scale should be stated whenever a mechanical analysis is reported. If separations of minerals are made by means of heavy mediums, such as methylene iodide and Clerici solution, the names of the mediums used should be given.

REFERENCE

Holmes, Arthur, 1920, The nomenclature of petrology: London, Thos. Murby & Co., 284 p.

MINERALOGIC TERMINOLOGY

New mineral names should be published only after sufficient study and comparison with similar minerals have left no doubt that the mineral is a new one. There is no restriction on the kind of name used; the mineral may be named for a person, a locality, or some property of the mineral, and it is conventional that the name end in "ite." The namer should consult standard reference works, such as Dana's "System of Mineralogy" and Hey's "Chemical Index of Minerals" to avoid using a name that is identical with one already proposed or whose pronunciation is close to an existing name. For instance, "allenite" is easily confused with "allanite" and "alunite." It is customary to explain for whom or what the mineral is named, and why, and if necessary the pronunciation of the name should be given.

Varietal names for minerals, such as "gedrite" for "aluminian anthophyllite," should be avoided if possible by the use of the adjectival modifiers proposed by Schaller (1930). For example, "argentian tetrahedrite" is preferred to "freibergite" and "ferroan magnesite" to "breunnerite." The scheme for forming these adjectival modifiers from the names of the chemical elements is briefly paraphrased from Schaller as follows:

The names of the chemical elements are placed in seven groups. In each of the first six groups all the names have the same ending; the seventh group includes names having various endings. The adjectival endings are formed according to the rules given for each group. Latin names are used for copper (cuprum), gold (aurum), iron (ferrum), lead (plumbum), silver (argentum), and tin (stannum). If lower valency is to be expressed, use "oan" instead of "ian," as in "ferroan" and "ferrian."

Group 1. If the name ends in "um," drop the "um" and add "ian."
Aluminum—aluminian
Tantalum—tantalian

Group 2. If the name ends in "ium," drop the "um" and add "an."
Barium—barian
Cerium—cerian

Group 3. If the name ends in "ine," drop the "ne" and add "an."
Bromine—bromian

Group 4. If the name ends in "on," add "ian," except for boron and silicon.
Carbon—carbonian
but
Boron—borian
Silicon—silician

Group 5. If the name ends in "gen," add "ian."
Hydrogen—hydrogenian
Nitrogen—nitrogenian
Oxygen—oxygenian

Group 6. If the name ends in "y," drop the "y" and add "ian."
Antimony—antimonian

Group 7. For the following names use the form shown.
Arsenic—arsenian
Bismuth—bismuthian
Cobalt—cobaltian
Manganese—manganian
Nickel—nickelian
Phosphorus—phosphorian
Sulfur—sulfurian
Tungsten—tungstenian

Where an element shows more than two valencies, the proper form can easily be made. Thus, for vanadium:

For vanadous vanadium, valency of 3, use vanadoan.
For vanadyl vanadium, valency of 4, use vanadylian.
For vanadic vanadium, valency of 5, use vanadian.

Some practical examples of this scheme follow:

Barian celestite
Calcian siderite
Rubidian lepidolite
Uranoan zircon (uranous uranium)
Uranian fergusonite (uranic uranium)
Zincian tetrahedrite

In addition, the following forms can be used:

Hydroxyl—hydroxylian
Sulfate—sulfatian
Carbonate—carbonatian
Phosphate—phosphatian

This scheme applies fully only to single isomorphous replacement. If the essential element of the mineral is replaced by more than one element, then the name of the element whose replacing effect is the largest, or is for some reason to be emphasized, should be used. The determination as to which element has the largest replacing effect should be based on molecular ratios and not on chemical percentages. If more than one essential chemical element in a mineral is partly replaced by other elements, then the element showing the greatest replacement effect should be chosen for the adjectival name.

The symbol used generally for the index of refraction, and specifically for the index for isotropic substances, is n. A variety of symbols are used for the indices of refraction for uniaxial and biaxial crystals, among which are the following:

Uniaxial	*Biaxial*
1. ω, ϵ	α, β, γ
2. n_ω, n_ϵ	n_α, n_β, n_γ
3. n_O, n_E	n_x, n_y, n_z
4. nO, nE	nX, nY, nZ
5. Ne, No	Np, Nm, Ng

The symbols listed first above are the ones most widely used among mineralogists throughout the world. These symbols have been adopted by the Mineralogical Society of America, the Mineralogical Society of London, the Mineralogical Association of Canada, the Geological Society of America, the American Chemical Society, and many other such organizations.

The names preferred for the 32 crystal classes are those of Groth as modified by Rogers, as set forth in Dana's "System of Mineralogy," 7th edition (see p. 67).

The symbols for face, form, and zone (or axis) are indicated by the type of brackets enclosing the indices. Thus, in the ditetragonal-dipyramidal class (001) refers to the face, at the plus end of the c axis, {001} to the two faces (001) and (00$\bar{1}$) that make up the form; [001] refers to the axis of the zone; any face within this zone is parallel to the line [001]. The space-group symbols are to be given first in terms of the International symbol and second in terms of the Schoenflies symbol. Thus, for murdochite, which is cubic, the statement would be $Fm\bar{3}m$ (O_h^5).

Two units of measurement have been used in the past in reporting X-ray data, the "angstrom unit" (A) and the "kX unit." All data should be given in angstrom units, one angstrom unit equaling 10^{-8} cm (A$=10^{-8}$ cm). Angstrom units are related to kX units by

the following equation: 1.00202 kX=A. To avoid ambiguity, however, the type of radiation and the wavelength value or values used should be specified in all X-ray work.

REFERENCE

Schaller, Waldemar T., 1930, Adjectival endings of chemical elements used as modifiers to mineral names: Am. Mineralogist, v. 15, p. 566–574.

Nomenclature of the 32 crystal classes

System	*Class name*
Triclinic	1. Pedial
	2. Pinacoidal
Monoclinic	3. Domatic
	4. Sphenoidal
	5. Prismatic
Orthorhombic	6. Rhombic-pyramidal
	7. Rhombic-disphenoidal
	8. Rhombic-dipyramidal
Tetragonal	9. Tetragonal-disphenoidal
	10. Tetragonal-pyramidal
	11. Tetragonal-dipyramidal
	12. Tetragonal-scalenohedral
	13. Ditetragonal-pyramidal
	14. Tetragonal-trapezohedral
	15. Ditetragonal-dipyramidal
Hexagonal P or R	16. Trigonal-pyramidal
	17. Rhombohedral
	18. Ditrigonal-pyramidal
	19. Trigonal-trapezohedral
	20. Hexagonal-scalenodhedral
Hexagonal P	21. Trigonal-dipyramidal
	22. Hexagonal-pyramidal
	23. Hexagonal-dipyramidal
	24. Ditrigonal-dipyramidal
	25. Dihexagonal-pyramidal
	26. Hexagonal-trapezohedral
	27. Dihexagonal-dipyramidal
Isometric	28. Tetartoidal
	29. Diploidal
	30. Hextetrahedral
	31. Gyroidal
	32. Hexoctahedral

CHEMICAL TERMINOLOGY

The following list of names of chemical elements and their symbols is in accord with those approved by the American Chemical Society. They should be used without change.

Chemical elements and symbols

Actinium	Ac	Germanium	Ge	Potassium	K
Aluminum	Al	Gold	Au	Praseodymium	Pr
Americium	Am	Hafnium	Hf	Promethium	Pm
Antimony	Sb	Helium	He	Protactinium	Pa
Argon	Ar	Holmium	Ho	Radium	Ra
Arsenic	As	Hydrogen	H	Radon	Rn
Astatine	At	Indium	In	Rhenium	Re
Barium	Ba	Iodine	I	Rhodium	Rh
Berkelium	Bk	Iridium	Ir	Rubidium	Rb
Beryllium	Be	Iron	Fe	Ruthenium	Ru
Bismuth	Bi	Krypton	Kr	Samarium	Sm
Boron	B	Lanthanum	La	Scandium	Sc
Bromine	Br	Lead	Pb	Selenium	Se
Cadmium	Cd	Lithium	Li	Silicon	Si
Calcium	Ca	Lutetium	Lu	Silver	Ag
Californium	Cf	Magnesium	Mg	Sodium	Na
Carbon	C	Manganese	Mn	Strontium	Sr
Cerium	Ce	Mendelevium	Md	Sulfur	S
Cesium	Cs	Mercury	Hg	Tantalum	Ta
Chlorine	Cl	Molybdenum	Mo	Technetium	Tc
Chromium	Cr	Neodymium	Nd	Tellurium	Te
Cobalt	Co	Neon	Ne	Terbium	Tb
Columbium (see niobium)		Neptunium	Np	Thallium	Tl
		Nickel	Ni	Thorium	Th
Copper	Cu	Niobium (columbium)	Nb	Thulium	Tm
Curium	Cm			Tin	Sn
Dysprosium	Dy	Nitrogen	N	Titanium	Ti
Einsteinium	Es	Nobelium	No	Tungsten	W
Erbium	Er	Osmium	Os	Uranium	U
Europium	Eu	Oxygen	O	Vanadium	V
Fermium	Fm	Palladium	Pd	Xenon	Xe
Fluorine	F	Phosphorus	P	Ytterbium	Yb
Francium	Fr	Platinum	Pt	Yttrium	Y
Gadolinium	Gd	Plutonium	Pu	Zinc	Zn
Gallium	Ga	Polonium	Po	Zirconium	Zr

Isotopes are commonly designated by the atomic number (the number of protons in the nucleus) and by the mass number (the number of protons plus the number of neutrons in the nucleus). In the United States it is customary to write the mass number as a right superscript, the atomic number as a left subscript, for example, ${}_{6}C^{14}$. Another form, which is used abroad, is to write the mass number as a left superscript, as, for example, ${}^{14}_{6}C$. In both usages, the atomic number is commonly omitted, as in C^{14}. Where the name rather than

the symbol is employed the mass number is printed on the line, following a hyphen—for example, carbon-14. The table below gives the nomenclature for the decay products in the uranium, actinium, and thorium series.

Nomenclature of radioactive decay products

[Listed in their order of formation. Brackets represent simultaneously existing nuclides in a branched decay scheme]

Uranium series		Actinium series		Thorium series	
Accepted isotopic nomenclature	Synonyms in older nomenclatures	Accepted isotopic nomenclature	Synonyms in older nomenclatures	Accepted isotopic nomenclature	Synonyms in older nomenclatures
U^{238}	UI, U_1, U_I	U^{235}	AcU	Th^{232}	
Th^{234}	UX_1	Th^{231}	UY	Ra^{228}	$MsTh_1$
Pa^{234}	UX_2, UZ*	Pa^{231}		Ac^{228}	$MsTh_2$
U^{234}	UII, U_{II}	Ac^{227}		Th^{228}	RdTh
Th^{230}	Io (Ionium)	[Th^{227}	RdAc	Ra^{224}	ThX
		[Fr^{223}	AcK		
Ra^{226}		Ra^{223}	AcX	Rn^{220}	Tn ("Thoron," also Em^{220})
Rn^{222}	"Radon" (also Em, "Emanation")	Rn^{219}	An ("Actinon," also Em^{219})	Po^{216}	ThA
Po^{218}	RaA	Po^{215}	AcA	Pb^{212}	ThB
Pb^{214}	RaB	Pb^{211}	AcB	Bi^{212}	ThC
Bi^{214}	RaC	Bi^{211}	AcC	[Po^{212}	ThC′
				[Tl^{208}	ThC″
[Po^{214}	RaC′	[Po^{211}	AcC′	Pb^{208}	ThD
[Tl^{210}	RaC″	[Tl^{207}	AcC″		
Pb^{210}	RaD	Pb^{207}	AcD		
Bi^{210}	RaE				
[Po^{210}	RaF				
[Tl^{206}	RaE″				
Pb^{206}	RaG				

*Different isomers of the same isotope having different half lives.

Chemical terms, rather than symbols, generally should be used in the text of a paper; thus, "Germanium (not Ge) was determined colorimetrically with diphenylfluorone"; the symbols may be used in tables, and also in the text where necessary to avoid complex terms.

Chemical analyses of rocks are generally reported in terms of weight percent of the constituent oxides. There is no ambiguity in so reporting, and it is a natural consequence that the geologist tends to write of chemical changes in terms of the oxides, as, for example, "The introduction of silica and alumina during metasomatism." Difficulties of expression arise, however, because there is no convenient term to use for total iron oxides. This situation results in inconsistencies such as

"Silica, magnesia, and iron were introduced." The difficulty is best resolved by discussing chemical changes in terms of the elements rather than of the oxides. The example above would be "Silicon, magnesium, and iron were introduced." It may happen, however, that the discussion refers directly to analyses that are stated in terms of the oxides; in such instances, the difficulty is best met by using chemical symbols: "In these rocks, the Fe_2O_3 content ranges from 0.26 percent in the granite to 0.84 percent in the diorite."

The following names of elements should not be used: aluminium for aluminum, didymium (Di) (an obsolete name for a mixture of rare-earth elements), and glucinum (Gl) for beryllium. The spellings sulfur, sulfide, and sulfate have been adopted by the American Chemical Society and by the Government Printing Office and should be used in place of sulphur, sulphide, and sulphate. Likewise, niobium (Nb) has been adopted and should be used in place of columbium (Cb), except that columbium is allowable in technical references such as to ferrocolumbium alloys. Similarly, as a chemical element mercury is to be used instead of quicksilver, as in "Mercury may be transported in alkaline sulfide solutions"; but in technical matter quicksilver is correct, as in "Quicksilver production was 295 flasks."

Either of two sets of adjectives pertaining to valence may be used, but Latin and Greek terms should not be mixed. The Latin terms are: univalent, bivalent, trivalent, quadrivalent, quinquevalent, sexivalent; the corresponding Greek terms are: monovalent, divalent, tervalent, tetravalent, pentavalent, hexavalent. Strictly speaking, the latter are Greek-Latin hybrids.

Valence may be expressed in any of the following ways: (1) Fe(II), Fe(III); (2) ferrous iron, ferric iron; (3) Fe++, Fe+++; and (4) Fe^{+2}, Fe^{+3}. Symbols omitting the + and − signs, such as Fe^2 or Cl^1, are not acceptable. Any of the above four ways may be used, but the first, which is recommended by the International Union of Chemistry, and the fourth are preferred.

The term "lime" (CaO) is commonly misused for calcium, as in "The orthoclase contains an unusual amount of lime." "Soda" means Na_2CO_3 and "potash" means K_2CO_3. These terms are commonly misused, either when the elements are meant, as in "potash feldspar" and "soda feldspar" (should be potassium feldspar and sodium feldspar), or when the oxide is meant, as in "The analysis shows 4.35 percent potash" (meaning K_2O). The correct terms for the oxides are "potassium oxide" and "sodium oxide." It is recognized that in technical usage, however, the term "potash" is deeply entrenched, as in "potash deposits of the United States," "potash" here being a catch-all word for the gamut of potassium salts.

The term "ion exchange" is preferable to the term "base exchange."

The preferred symbol for oxidation-reduction potential (redox potential) is "Eh."

BIOLOGIC MATTER

Biologic matter includes systematic descriptions of fossil or living organisms, lists of identified plants or animals, general biologic or paleontologic discussions, and tables and keys of various sorts. This discussion merely summarizes some practices and definitions considered important for Geological Survey authors. It is by no means exhaustive, and its recommendations are not intended to preclude reasonable alternative usage in matters of choice.

Codes of systematic nomenclature have been formulated by international commissions for botany and zoology. These codes, or "rules," as well as interpretations and discussions of them, are readily available (Schenk and McMasters, 1956; Lawrence, 1951, p. 192–222; Lanjouw and others, 1952 and 1956; Mayr and others, 1953, p. 203–211; Hemming, 1953[3]). Authors of Survey reports that include biologic matter should become familiar with the pertinent code or codes or should consult specialists for advice on validity, orthography, and authorship of names. Interpretation of the applicable rules involves a large element of individual judgment, and it is advisable to know what experienced systematists think.

CITATION OF SYSTEMATIC NAMES

Systematic names are arranged in order of rank to indicate their relationship. The broad categories are specific, generic, and suprageneric. Specific names include not only those of species in the strict sense but also those of geographic or stratigraphic subspecies and of varieties within local populations of a given species. Generic names include those of genera and subgenera. Suprageneric names include the higher categories—family, order, class, phylum, kingdom, and the various intermediates indicated by prefixes "sub," "infra," and "super." "Taxon" is the term used to indicate a taxonomic unit of any rank, or of unspecified rank.

All formal systematic names are latinized and should follow the rules of Latin grammar. Anyone who has to deal with systematic material, particularly if he has occasion to formulate new names, should have access to authentic guides on the procedures to be followed and the meanings and combining forms of frequently used and available classical words and word parts. A book by Brown (1954) is helpful and includes references to earlier works.

Generic and suprageneric names consist of a single term beginning with a capital letter as, for example, *Conularia*, Hydrozoa. Names of species consist of two parts—the appropriate generic term followed by

[3] A revision of the Zoological rules is in progress (1957) and will supersede earlier references.

the specific term, which is not capitalized except under conditions permissible in botanical nomenclature. Names of subgenera are given in parentheses after the name of the including genus, but the parentheses are dropped where the subgeneric name stands alone. Thus we refer to the species *Linoproductus* (*Cancrinella*) *phosphaticus* Girty, but use *Cancrinella* in reference to the subgenus only. Subspecific and varietal terms follow species names and are subject to the same rules as species. A taxon need not be named formally if there is a desire to recognize it but not to name it; it can be designated by letter or number, or simply be noted as unnamed.

Physical geologists should not be confused by the common and entirely appropriate differences among paleontologists on the status and use of generic and subgeneric terms. A subgenus to one may be a genus to another, and still further legitimate disagreement arises over the propriety of particular generic assignments. Similar disagreements with regard to species versus subspecies are probably as common but seem to cause less confusion.

Formal generic and specific names of all ranks are ordinarily italicized in text. Suprageneric and anglicized names are not italicized—"The genus *Spirifer* is in the family Spiriferidae, which includes the true spirifers."

Generic terms may be abbreviated to the capitalized initial where they are a part of a species name, and where such abbreviation follows previous writing of the full term under conditions that leave no doubt about the meaning of the initial.

It is ordinarily desirable that the name of the first author or founder of a species be indicated, although to do so is not required by zoological rules. Without the name of the founder, synonyms of species are difficult to segregate, and search for previous records is hampered. However, founders' names need not be repeated in general discussions, where they are clear from antecedent usage or given in summary lists or tables. Where cited, the founder's name follows the systematic name without punctuation and is not italicized. Names of founders should not be abbreviated except in direct quotation, or unless reference is made to appropriately comprehensive published lists of accepted abbreviations. The year a taxon is described may follow the author's name, separated by a comma. The use of the date is optional but is helpful in locating the original reference to the taxon.

A species originally described as belonging to one genus and later transferred to another is indicated by enclosure of the original describer's name in parentheses. In botanical reports the original describer's name is followed by the name of the person responsible for the amended usage, the latter without parentheses; botanists also commonly supply dates. Thus *Sequoia langsdorfi* (Brongniart) Heer

was described as *Taxites langsdorfi* by Brongniart and transferred to *Sequoia* by Heer. The practice of giving the reviser's name is optional in zoological nomenclature, but if employed should be followed consistently throughout a report.

Degrees of doubt.—Question marks, the standard Latin abbreviations "cf." (confer) and "aff." (affinis), and quotation marks indicate different degrees of doubt in identification of species and genera. "Cf." indicates general similarity and the possibility that identity might be established if direct comparison were possible, or if adequate material were available for comparison. "Aff." implies close affinity but probable or known difference in detail. Conventionally the initial of the genus is repeated after "cf." or "aff.," as *Eumetria* cf. *E. altirostris* White, signifying that the specific term does not stand alone. Some nomenclators, however, use the shorter designation *Eumetria* cf. *altirostris* White.

The position of a question mark indicates different shades of doubt. A query indicating doubtful reference or identification follows the term that is in doubt, the founder's name being considered for this purpose as a part of the specific term. A query preceding the whole name indicates that all of it is in question. Question marks should stand against the doubtful term without space between, and they should not be enclosed in parentheses. In lists, tables, and synonymies no punctuation mark should be used after a question mark following a systematic name; in text, punctuation is used as if the query were not there. Names of very broad or probably erroneous usage are commonly indicated by quotation marks.

Common usages are illustrated by the following:

Leptaena cf. *L. rhomboidalis* (Wilckens)—Similar to *L. rhomboidalis* and possibly conspecific with it.

Leptaena aff. *L. rhomboidalis* (Wilckens)—Closely related to *L. rhomboidalis* but possibly a different species.

Leptaena? *concava* Hall—Genus in doubt, but identification at the species level considered certain.

Leptaena rhomboidalis? or *L. rhomboidalis* (Wilckens)?—Species in doubt, but generic determination believed to be correct.

?*Leptaena rhomboidalis* (Wilckens) or appropriate combination of preceding, such as *Leptaena*? cf. *L. rhomboidalis*—Whole identification doubtful.

"*Leptaena*" *concava*, *Leptaena* "*rhomboidalis*," "*Leptaena analoga*"—Quoted names used in a very broad or probably incorrect sense.

Although the foregoing examples do not express precisely all degrees of doubt, efforts at greater refinement are likely to confuse the reader as well as the author.

Plural, anglicized, and unpublished names.—A plural formed by simply adding "s" to the Latin name is not ordinarily italicized but may be capitalized: pectens or Pectens, chrysanthemums or Chrys-

anthemums, mastodons or Mastodons. The anglicized form of a Latin name, such as dinosaur, bryozoan, and diatom, is not capitalized; and coined words, such as ammonoid, equid, aceriform, foraminifer, and terebratuloid, are neither capitalized nor italicized.

Unpublished names and also names that were originally published without a description are invalid (nomina nuda) until described, and they may not be included in any Survey report printed or placed in open file, except as necessary to refer to previous invalid publication. Use of such names leads to confusion even if the name is stated to be in manuscript and is known to be in progress toward publication.

Importance of source.—Those who cite the systematic identifications and opinions of others should quote them accurately, with original qualifying statements and with clear reference to source and date. For future evaluation the name of the systematist responsible is as important as the name of the organism identified. Information on the place and circumstances of the determination also may be desirable if the data cited are extensive or unusually significant.

LISTS AND DISTRIBUTION TABLES

Whether lists and distribution tables are an important supplement to reports in which they are used is determined by their pertinence and organization, as well as by the care with which they are compiled. Commonly it is unnecessary to reproduce all the information acquired in order to reach a conclusion. The author, with the aid of competent specialists if needed, should select the data that significantly affect the validity of the conclusion. Careful attention should be given to arranging the data in an informative and practical way, considering publication cost and format.

The importance of fixing responsibility for systematic determinations and interpretations based on them is emphasized above. If more than one systematist has contributed to a list or table, the responsibility for each identification should be made clear.

SYSTEMATIC DESCRIPTIONS

The purpose of systematic description is to record the principal characteristics of the taxon under consideration, differentiate it from similar units of the same rank under the same higher category, and place it systematically. Descriptions of taxons, whether new or old, should be under an appropriate centerhead.

Formal description of a species should include:

1. An indication of its taxonomic rank, to the extent not obvious from context or common knowledge.
2. A reference to the original description, if the species has been previously described, or indication that the species is new.

3. A **synonymy,** or citation of significant previously published and personally verified references to the same species, insofar as appropriate.
4. A description and discussion, which should include pertinent quantitative data and particular differentiation from similar forms. Where a description is long it is well to include a concise summary of distinctive features as a leading paragraph.
5. A designation of a single name-bearing type specimen, the **holotype,** with reference to repository and catalog number; other specimens in the type lot are **paratypes.**
6. Sufficient indication of other material studied to establish a basis for the author's concept of the species.
7. The known stratigraphic and geographic distribution of the species and as precise a description of the locality and stratigraphic position of the type material as can be given.
8. An illustration (or illustrations) revealing the significant features of the species.

Descriptions of subspecies and varieties ordinarily can be much abbreviated, as the differentiation of these taxons from others in the same species is the matter of chief interest.

Where several species are described under a single genus, their descriptions should be condensed so as to omit features at the generic level. Except for new forms, tabular comparison of essential similarities and differences may satisfy systematic requirements better than long narrative descriptions, and may usefully supplement formal description where the latter seems necessary. In any event, it is not ordinarily desirable for the description of the species to repeat characteristics described as of generic significance.

Descriptions may be written out in full sentences or may be in telegraphic form, according to the preference of the writer; but mixing of the two styles in the same or comparable paragraphs should be avoided. Consistent organization is desirable so that structures or characteristics are discussed in about the same order in successive descriptions within a biologic group.

Generic description includes the essential elements of specific description, with special emphasis on the unambiguous designation of the type species. As for suprageneric categories, it is a general rule that the larger they are the more briefly and surely they can be characterized and differentiated. The appropriate taxon should be designated as the type, according to the applicable rules of nomenclature.

The problem of types in general is lucidly discussed by Simpson (1940). The interested reader should consult also Simpson (1945), Lawrence (1951), or Mayr and others (1953) for helpful extensions

of this brief discussion and general summation of the principles of taxonomy.

Synonymy.—Systematic descriptions of species and genera ordinarily begin with an organized list of references to previous publications, called a synonymy. The synonymy is not a routine requirement and may be dispensed with under appropriate circumstances, as by reference to an adequate published synonymy.

A good synonymy is not merely a list of the previously published appearances of a particular name. Rather, it is a file of selected references to a well-defined class of objects, under whatever name cited. The synonymy, plus new material studied, is the proper basis of the immediate author's concept of the species or genus. Synonymies, therefore, should include only pertinent citations personally verified by the author, from examination of original publications or specimens, and included in his concept of the species. An exception is made for verbal synonyms and for dubious records, duly questioned, which may be included in the synonymy for special reasons.

Synonymies can be arranged in several ways, but they fall in two general categories—those that stress the chronology of the synonymic names and those that stress the chronology of the bibliographic references. In the first kind the specific name should be followed by the name of the author, followed by the bibliographic citation. For example, see Todd and Post (1954, p. 555.) In the second kind the year of publication is followed by the specific name, the author, and the bibliographic citation. For example, see Cole (1954, p. 589.) The two general kinds and some variations are discussed by Schenk and McMasters (1956, p. 17–23) with pertinent comments on the relative merits of each. Seven styles are briefly outlined by Tyler (1953, p. 61–62).

A commonly used Survey form cites first the founder's description; next, references accepted by the immediate author, in chronologic order; and finally, if desired, verbal synonyms and misidentifications, also in chronologic order. A strictly chronologic synonymy is almost as common and just as acceptable. No punctuation is used between the name of a species and the names of its founder and combiner, but a period is used to separate these names from those of other authors cited. It is not necessary to follow authors cited in capitalizing specific names.

Synonymy citations are conventionally given in the style prescribed for bibliographic citations, except that generally author's initials are omitted and titles of papers in journals or other serial publications also are left out. The use of bibliographies at the end of reports, however, permits synonymy citation to be cast in the still briefer and increasingly practical form of author, year, page, and illustration ref-

erence only, as used in running text. Either usage is acceptable. The latter has the great advantage of brevity, but it imposes the inconvenience of searching the bibliography for complete references. If the longer form is used, without a terminal bibliography, caution should be exercised that clarity is not sacrificed for brevity. Choice of style may well depend on the purpose of the report and the frequency with which references to the same works are repeated, but the style selected should be followed consistently.

Quantitative data.—It is generally preferable to separate the qualitative and quantitative parts of a description, the method used depending on the size and nature of the population sample studied. Except for very small samples, quantitative data are probably most effectively presented in tabular or graphic form.

A growing interest in the more rigorous expression of systematic judgments has led to much recent discussion of the presentation and analysis of statistical data. However, at present (1957) the only general summaries prepared with the needs of paleontologists especially in mind are those of Simpson and Roe (1939) and Imbrie (1956).

Illustrations.—Illustrations are the heart of systematics, and they are required in establishing new species or subspecies. They should be selected and prepared so as to achieve good balance and coverage in appropriate style and at suitable magnifications. Accuracy within realistic limits and appropriate highlighting of critical features are more important than artistic execution, but the effect should be harmonious. Coverage and magnification should be planned to avoid lavishness without introducing ambiguity or causing eyestrain. Critical parts of organisms may be shown by illustrations reproduced at scales larger than are suitable for the whole unit. Limits of variation in population samples should be indicated without overillustrating intermediate forms; total variation is best shown graphically.

Illustrations preferably should be arranged on plates in the same order that they are described in the text, and all views of a single species should be kept together, if possible. (See p. 130–131.)

In plate explanations the generic, specific, and founders' names should be given, views of fossils and magnification defined, significant structures noted, locality and key stratigraphic data given, and type or other appropriate catalog number cited. Reference to text page should be provided. Descriptions of individual illustrations should be doublechecked for correspondence with proper figure and plate numbers; also figure and plate numbers should be checked for correspondence between text and plate explanation.

Text figures and graphs should be used where helpful in supplementing conventional systematic illustrations, such as sketches showing biologic affinities and major morphologic variations.

Interpretive material.—Careful description is the first and most essential step in systematics. To describe an organism adequately requires meticulous observation, technical skill, and a thorough familiarity with the organism and the group to which it belongs. The naming, precise description, and proper arrangement of the objects of systematic study, however, call upon and lead to much more than the observation of detail; and the objectives and principal conclusions of systematic work deserve more attention than they sometimes get.

Authors of primarily systematic papers should, as a matter of conscious course, consider what interpretive discussions may be included in their reports. Most such studies contribute something useful to paleoecology, phylogeny, the mechanics of adaptation and evolution, stratigraphy, or sedimentation; and the author is in the best position to suggest what the contribution might be. Conversely, it is desirable that adequate systematic treatment and illustration be included in primarily stratigraphic or interpretive papers. Careful separation of fact and interpretation should, of course, be maintained throughout all such discussions.

Abbreviations and Latin expressions.—For Survey reports the English forms "n. gen.," "n. sp.," "n. var.," "s. s.," "not," "part," "cf authors," "undet.," "position uncertain," and "in series" are preferred to the Latin "gen. nov.," "sp. nov.," "var. nov.," "s. str.," "non," "pars," "auct.," "indet.," "incertae sedis," and "seriatim" respectively. However, the Latin is used for "nomen nudum" (plural "nomina nuda") and for "s. l." ("sensu lato").

English plurals also are preferable to Latin or Greek plurals for classical nouns in common use (electron, electrons; but datum, data), unless the result is barbaric. Where Latin plurals are used, they should be correct; the plural of punctum is puncta, not "punctae." This suggestion is not to be construed as prohibiting the use of Latin or other foreign expressions where their nearest English equivalents do not conform to good taste or do not convey the precise meaning intended.

LOCALITY RECORDS

Precise locality records, including pertinent stratigraphic data, are essential. Although such records may commonly be abbreviated through judicious use of locality maps and reference to supplemental data in accessible permanent files, all systematic papers should include them.

KEYS AND IDENTIFICATION TABLES

Keys and tables enhance the usefulness and improve the presentation of paleontologic data. Tables enable the reader to compare at a glance, and in order, the presence, absence, and degree of development of distinctive features of related species in a genus (or genera)

in larger systematic units. Where many units are involved or tabular presentation is not practical for other reasons, keys are helpful.

A key should be simple, direct, and dichotomous. The members of each couplet should be mutually exclusive—ideally the first member is a brief positive statement and the second a simple negation of the first. Keys should be so constructed that they can be used either backward or forward, without superfluous steps. Where the features differentiated are hard to describe briefly, simple diagrammatic illustrations are helpful.

Good discussions of keys, with examples, are given by Lawrence (1951, p. 225–228), Mayr and others (1953, p. 162–168), and Metcalf (1954).

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GEOLOGIC NAMES

The stratigraphic classification and nomenclature of rock units in all manuscript reports prepared by members of the Geological Survey are reviewed for conformity with accepted Survey usage, whether the

reports are to be published by the Survey or by an outside organization and whether they result in whole or only in part from the official work of Survey members.

The obligation of examining reports for conformance with Survey usage falls upon the review staff of the Geologic Names Committee. The committee came into being as a result of early efforts to meet the need for a cartographic system that would be applicable throughout the country and that would at the same time establish for the Geological Survey certain rules concerning the nomenclature to be used on geologic maps. The committee was first organized on February 17, 1899, to investigate and make recommendations on names of geologic formations where there was conflict. Later it was authorized to consider all names of geologic formations or other divisions of rocks with a view to determining whether they comply with the rules of nomenclature adopted for Survey publications and to recommend such action as might be advisable in any individual case to achieve reasonable consistency in nomenclatural practice.

The U. S. Geological Survey follows the rules for the classification and nomenclature of rock units published in 1933 (Ashley, G. H., and others). Survey authors may refer to this code of rules (published in Geol. Soc. America Bull., v. 44, p. 423–459 and in 1939 in Am. Assoc. Petroleum Geologists Bull., v. 23, p. 1068–1088) or request an official copy from the Geologic Names Committee.

The rules are administered in the Geological Survey as follows:

1. The official classification and nomenclature of rock units shall be that established to date by the rulings of the Director and the chief geologist and contained in the records of the Geologic Names Committee.
2. The classification and nomenclature of rock units in reports offered for publication by the Geological Survey shall be in accord with the official classification and nomenclature, but an author in his text may express a personal opinion at variance with them.
3. The classification and nomenclature of rock units in reports offered for approval for publication outside the Geological Survey's regular channels shall generally accord with the official classification and nomenclature but may, with the approval of the Director, differ from them.
4. The classification and nomenclature of rock units in reports that embody the results of cooperative investigations with State geological surveys or other organizations shall accord with the official classification and nomenclature; except that if such manuscripts are published by a cooperating organization that uses a classification different from that of the U. S. Geological Survey, the report may give the classification of the cooperating organization, in

which case the departure from the Survey's usage shall be pointed out in a footnote or elsewhere in the text.

5. All reports that result in whole or in part from official work of Geological Survey members and that contain stratigraphic names shall be submitted to the Geologic Names Committee. Exceptions to this rule include material to be released in open files with a disclaimer and occasional material using only a few well-established names if specifically exempted by the Director or his deputy.
6. Under general direction of the chairman, who will also be chief of the committee's review staff, the secretary of the committee will be the immediate supervisor of the review staff, and will be responsible for the examination of submitted manuscripts to determine whether the classification and nomenclature of rock units used in them accord with Survey rules. Where there are departures from the official classification and nomenclature, the committee shall consider whether the departures shall be adopted as a new official usage, or be approved for use in the particular manuscript without prejudice to the official usage, or be rejected.

   Departures from the official usage that are considered by the committee include such items as the proposal of new names, the redefinition of old names, the geographic extension or restriction of old names, and new age assignments of units. But, to expedite the handling of manuscripts in the interest of efficient operation, relatively minor departures from official usage need not be brought to the attention of the full committee; they may be approved by the chairman and the secretary of the committee through conferences with the authors and with specialists on the committee.
7. Prior to a committee meeting an agenda shall be submitted to regular and temporary members.
8. The minutes of the meetings of the committee containing a record of the discussion and recommendations of the author and of the members of the committee in the consideration of a manuscript shall be submitted for approval to the chief geologist, who is empowered by the Director to rule on recommended changes in nomenclature. The approved minutes shall be placed in the committee's files for consultation by all interested persons.
9. After a manuscript has been reviewed by the Geologic Names Committee, no changes in the usage, classification, and nomenclature may be made without consulting the committee. The author or members of the committee may appeal to the chief geologist for reconsideration of any point and, if a difference of views continues, final appeal may be made to the Director.

RECORDS ON GEOLOGIC NAMES

The Geologic Names Committee for many years has maintained systematic records, which include not only an index to the work of the committee throughout its history but an index to publications on the stratigraphy of the United States, so far as names and classification are concerned.

Much of the information in these records is based on works on stratigraphy published before 1937 and thus is available in the lexicon compiled by Wilmarth (1938) and in the State stratigraphic charts released by the Geological Survey between 1925 and 1935. Information concerning stratigraphic names published after 1936 can be obtained in "Geologic Names of North America Introduced in 1936–1955," by Wilson, Sando, and Kopf (1957).

Services offered both to Survey and to non-Survey geologists by the committee, upon request to the Secretary, Geologic Names Committee, U. S. Geological Survey, Washington 25, D. C., include information on the following subjects:

1. Questions on the nomenclature and status of rock units, such as whether a geographic name has had previous use as the name of a rock unit.
2. The original and current definitions of a particular unit.
3. The currently accepted age or classification of a particular unit.
4. Reservation of new names for stratigraphic units.
5. General or specific information on similar matters that may be found in the committee's records.

If an author, either Survey or non-Survey, requests the reservation of a name that never has been applied to a stratigraphic unit, an informal record of that author's intention is preserved for the information of others who may inquire about the name. However, the committee does not presume to pass judgment on the validity or use of any name outside the reports and maps of Geological Survey authors, nor do its suggestions or recommendations contain any element of obligation for non-Survey authors to conform to Survey practices.

ACCEPTED NAMES

The stratigraphic names accepted for official Survey usage include only those proposed by the authors of the Geological Survey's reports and maps. The file of such names has grown constantly as new stratigraphic information has become available through investigations since the early days of the Geological Survey. In the course of new Survey investigations, authors should always consult the secretary of the Geologic Names Committee to determine which stratigraphic names have been accepted for the area of study.

Numerous names that have not been considered for Survey use are in current use by non-Survey geologists. No implication of rejection applies to names not so considered. If it is desirable to refer to names that have not been accepted, or not proposed for acceptance (but which have been used by others), such names may be referred to as, "the Branchtown clay of Lewis (1881)." If it is desired to propose for adoption by the Geological Survey an existing name that has not yet been officially accepted, the committee should be provided with a reference to the original definition, a quotation thereof, or a redefinition if the original description is inadequate or if the definition of the unit is being changed. If the unit is to be redefined, a historical summary should be given.

FUNCTIONS OF THE REVIEW STAFF

The function of reviewing manuscripts for the Geologic Names Committee is delegated to a review staff, whose members are responsible only for assuring adherence to current Survey usage. Appeal to the committee is the prerogative of all authors, and is a duty where they believe official nomenclature to be in error.

PROPOSING NEW NAMES

All sedimentary formations should receive distinctive designations. The name should be binomial, the first part being geographic, the other lithologic, unless the formation consists of beds differing greatly in constitution so that no single lithologic term is appropriate, in which case the word "formation" is substituted. The geographic term should be the name of a stream, mountain, town, or other natural or artificial feature at or near which the formation is typically represented.

The discrimination of units among the igneous and metamorphic rocks of any region is desirable. The name by which an igneous or metamorphic unit is designated may consist of the petrographic term alone or may be a combination of a geographic and a petrographic term.

Names applied to subsurface units are governed by the same rules as those for exposed units. New names, however, should not be founded on subsurface occurrences unless the subsurface unit is significantly different from equivalent rocks in the outcrop, its correlation is uncertain, or it has no outcropping equivalents.

If new stratigraphic names are proposed in a report, authors should send to the secretary of the committee, through their supervisors and at the earliest possible date, a list of such names and should give the area in which the names are to be used. The names will be checked and, if they have not been used, will be reserved for the report. If

the names have been used, the author has an opportunity to select other names before the report is completed. More than one choice of a name may be submitted. If reserved names are not used, the committee should be informed promptly so that their availability can be reestablished. The completed report should contain at least the following information about a new name:

1. Statement of intent to introduce a name, such as "This unit is here named * * *."
2. Geographic feature from which the name was taken. Specific location of one or, if desirable, more than one typical section near the geographic feature. For subsurface units the location and the name of the type-locality well should be given.
3. A map showing the location of the type section, either on a geologic base or with reference to a published geologic base, and with sufficient precision to permit another geologist to find all important points in the field.
4. Description of the upper and lower contacts, where possible.
5. Summary description of lithologic features.
6. An interpretation of the age and correlation, where possible.

A choice should be made to avoid multiple names such as "Crazy Horse Canyon" formation. Avoid geographic names based on minerals or chemical quality of water, such as sphalerite and chalybeate. Avoid oddities such as "Lucky Bill," "Whispering Willie," "Beechatuda Draw," and "Mills Mills." If it is necessary to use names that are difficult to pronounce, the phonetic pronunciation should be given in parentheses after the name where it is first used in the text.

New stratigraphic names should not be introduced in a separately published abstract, for its essential conciseness does not permit full definitions that are specified by the code of rules on nomenclature. The introduction of new names in an abstract that is published before the full paper appears may cause inconvenience to other geologists. Often, such an abstract and the subsequently printed final paper display significant changes in the nomenclature. Therefore, new stratigraphic names should be mentioned in an abstract only if it accompanies the full paper.

STRATIGRAPHIC SUMMARY

Before completion of manuscripts involving several stratigraphic names and correlations, a stratigraphic summary including sketches of the proposed map explanation, correlation charts, and other diagrams pertaining to problems in stratigraphy may be submitted for preliminary review by the committee. Many questions can be answered and wasted effort avoided by such review before the manuscript and illustrations are in final form.

CONSISTENT USAGE

Usage of terms should be consistent throughout any particular report. Confusion sometimes arises with terms such as "the Dakota"; the Dakota is a sandstone in most areas but a quartzite in some, and in some others it is of mixed character and is called "Dakota formation." It is of formational rank in most areas, but of group rank in some. The Raritan formation is an example of another type that may cause confusion; it is divided into the Lloyd sand member (formal name) and a clay member (informal). It would be incorrect to refer to the clay as the "Raritan clay"; the correct use is "clay member of the Raritan formation." In maps, paragraph headings, and the first use of the name in a paragraph, the proper reference to the formal name "Lloyd" would be "Lloyd sand member of the Raritan formation." If the name is used several times in a paragraph, the subsequent references might be to the "Lloyd" or the "Lloyd member," but not to the "Lloyd sand." If a particular lithologic facies is present in a formation, reference to the facies should indicate that it is part of the formation, such as "the sandstone facies of the Fountain formation," and not "the Fountain sandstone."

DISCUSSION OF STRATIGRAPHY

In describing the stratigraphy of an area, the author should keep the following points in mind:

1. The stratigraphy of an area generally is discussed chronologically, the oldest formation first and the youngest last. This order of description, however, does not necessarily apply to a measured section of a formation or to the discussion of the strata penetrated in a drill hole. For some small areas where geologic information is based largely on drill records (such as groundwater areas, oil fields, and areas where the rocks are poorly exposed) the author may find it advantageous to discuss the stratigraphy from youngest to oldest.
2. The first time a term is used in a manuscript, the age of the unit should be given if it is not indicated by title, discussion heading, or generalized geologic column—for example, the "Phosphoria formation of Permian age."
3. "Lower," "Middle," and "Upper" indicate position in the geologic column; "Early," "Middle," and "Late" designate time. Capitalized terms indicate formal series and epochs; lowercased terms indicate informal subdivisions. The intrusion of an Upper Jurassic batholith would be a Late Jurassic event. An upper Pleistocene till is of late Pleistocene age.

446304 O—58——7

4. The lexicon compiled by Wilmarth (1938) should not be cited as the authority in discussions of stratigraphy. Reference should be made to the original articles upon which the data in the lexicon are based.

PREFERRED TERMS

Awkward combination of descriptive terms and colloquialisms should be avoided, such as—

1. Use of "sediments" or "deposits" for consolidated sedimentary rocks.
2. "Metamorphics" for "metamorphic rocks."
3. "Volcanics" for "volcanic rocks."
4. "Cambro-Ordovician" for "Cambrian and Ordovician."
5. "Permo-Carboniferous" for "Carboniferous and Permian."

The term "beds" is not used with the proper names of formations or members, such as "Nunda sandstone beds," but is permissible with a time term such as "beds of Mississippian age."

"Rocks similar to those of the Traverse group" is preferred to "Traverse-type rocks."

"The Dundee limestone of Devonian age" is preferred to "the Devonian Dundee limestone."

LETTER SYMBOLS

The standard letter symbols used by the Geological Survey on geologic maps consist of a capital letter, indicating the system, and one or more lowercased letters designating the formation and member where used. The letter symbols for the systemic terms are as follows:

Q	Quaternary	M	Mississippian
T	Tertiary	D	Devonian
K	Cretaceous	S	Silurian
J	Jurassic	O	Ordovician
Tr	Triassic	Є	Cambrian
P	Permian	pЄ	Precambrian
IP	Pennsylvanian		

The letter symbol C should be used to designate the Carboniferous systems in regions where the Pennsylvanian and Mississippian systems are not differentiated.

The second letter of the symbol is generally the first letter of the formation name, as in Tc for Calvert formation of Tertiary age. If a formation name is made of two words—for example, Fort Union formation—there is a choice of symbols, in this instance Tf or Tfu. If members of the Fort Union are mapped, the first letter of the name is commonly used with the first letter of the member name, as in Tfl

for the Lebo shale member of the Fort Union formation. This method keeps the symbol from becoming unnecessarily long. Do not use complex multiple letter symbols; for example, the Death Canyon member of the Gros Ventre formation should not be Ꞓgvdc, but Ꞓgd. No symbol should include more than four letters.

For a mapped unit of Precambrian age that does not bear a formal name but is referred to only by rock type as, for example, gneiss, the symbol may consist of the first two letters of the rock type. The letter symbol for the rock type need not be preceded by the age symbol.

On maps showing metamorphic rocks, where it may be desirable to show the metamorphic zones or facies involved in the various stratigraphic units, a letter symbol may be used to indicate the type of zone or facies. The letter symbol and the boundaries of the zone or facies may be overprinted on the map in a color differing from that used for the formation symbols and boundaries.

The symbols that are to be used on a given geologic map should be based on practicability. The number of units and the number of systems shown and the rock types of an area are important factors in the choice of letter symbols.

MINOR STRATIGRAPHIC UNITS

The names by which minor stratigraphic units of economic interest are known locally, such as oil sands, coal beds, and construction or ornamental stone, may be used in publications of the Geological Survey. This applies to surface and subsurface occurrences of these rocks. However, the text should state that the names are of local usage. This decision applies to such terms as "Big Blue sand," "reef beds," and "fire-clay seams." If the term has been replaced by a geographic formation name or member name, the formation or member name is used, but the economic term may be used in parentheses without quotation marks, as follows:

Burgoon sandstone member (Big Injun or Mountain sand)
Greenbrier limestone (Big lime)
Morgantown sandstone (Murphy sand)
Mettawee slate (Vermont green slate)
Holston limestone (Tennessee marble)

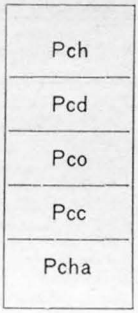
Water-bearing formations (aquifers) also may be named, but only where stratigraphic names cannot be used—for example, where the aquifer crosses stratigraphic boundaries or where an aquifer is known to exist but the local stratigraphy has not been worked out. To avoid confusion with stratigraphic units, aquifers to be named preferably should be given broad, regional names.

MAP EXPLANATIONS

For maps in book publications, authors should not include in the explanation descriptive material that belongs in the text. For maps having an abbreviated text, as in some of the map series, some expansion of the descriptive material in the explanation may be necessary, but the expansion should contain little or no duplication of material given in the text, unless some features, such as ore-bearing rocks and water-bearing qualities of rocks, merit emphasis.

In preparing map explanations the following points should be observed:

1. The sedimentary, igneous, and metamorphic rock units shown on the map explanation should be combined in a chronologic sequence where practicable. A chronologic arrangement regardless of origin of the rocks facilitates the interpretation of the structure and geologic history of the area mapped. Exceptions will have to be made and separate columns used because of (a) the broad range in age or indefinite age of igneous rocks (especially intrusive rocks) in some areas, (b) different facies of sedimentary rocks in a limited area, (c) equivalent age of different types of deposits of the Quaternary system, (d) the necessity of combining into a single map unit several rock units of different ages in a particular part of the map area, and (e) State geologic maps and other regional maps where rock units of the same age have different names in different parts of the area covered. When separate columns are necessary the chronologic sequence of rock units can be maintained on some map explanations with a system of bracketing to the correct age position.
2. System names are in capital letters on the right side of the explanation.
3. Series names are preferably on the left side of the explanation and are lowercased (the initial letter of the series name is a capital).
4. Group names also may be on the left side, indented from the series brace, lowercased (the initial letter of the group name is a capital).
5. Formation names and descriptions are centered under boxes, lowercased (the initial letter of the formation name is a capital).
6. The discussion of members or tongues of a formation should be in the order of their stratigraphic position, youngest at top, and the symbols should be in the order discussed, as in the following example (note omission of final periods):



Cutler formation

Consists of Hoskinnini tongue, Pch; *De Chelly sandstone member,* Pcd; *Organ Rock tongue,* Pco; *Cedar Mesa sandstone member,* Pcc; *and Halgaito tongue,* Pcha

7. The position of terms of equal rank should be consistent.
8. The words "system," "period," "series," and "epoch" are not abbreviated. Abbreviations of other words should be avoided, if possible; where they are necessary in illustrations the following are recommended:

group	gr	shale	sh
formation	fm	limestone	ls
member	mbr	conglomerate	cgl
sandstone	ss	quartzite	qtzite

Note the absence of periods. If it is necessary to use these abbreviations in reduced type in a compendium, such as the "Lexicon of Geologic Names," the periods are retained.

MAJOR DIVISIONS OF GEOLOGIC TIME IN USE BY THE U. S. GEOLOGICAL SURVEY

The accompanying tables (p. 90, 91) show the accepted names for eras, systems or periods, series or epochs in use by the U. S. Geological Survey in 1957, and the approximate length in millions of years determined for each period of the earth's history.

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Ashley, G. H., and others, 1933, Classification and nomenclature of rock units: Geol. Soc. America Bull., v. 44, p. 423–459; reissued, 1939: Am. Assoc. Petroleum Geologists Bull., v. 23, p. 1068–1088.

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MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U. S. GEOLOGICAL SURVEY

Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years [1]
Cenozoic	Quaternary	Recent	
		Pleistocene	1
	Tertiary	Pliocene	10
		Miocene	25
		Oligocene	40
		Eocene	60
		Paleocene	
Mesozoic	Cretaceous [2]	Upper (Late)	
		Lower (Early)	125
	Jurassic	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	150
	Triassic	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	180
Paleozoic	Permian [2]		205
	Carboniferous systems: Pennsylvanian [2]	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	
	Carboniferous systems: Mississippian [2]	Upper (Late)	
		Lower (Early)	255
	Devonian	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	315
	Silurian [2]	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	350
	Ordovician [2]	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	430
	Cambrian [2]	Upper (Late)	
		Middle (Middle)	
		Lower (Early)	510
Precambrian [2]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	> 3,000

[1] Age values given are the Holmes "B" time scale points (Holmes, A., 1947, The construction of a geological time scale: Geol. Soc. Glasgow, Trans. v. 21, pt. 1, p. 145). Dates are rounded to the nearest 5 million years. The errors are unknown, but more recent age determinations by various physical methods are in general agreement with these values.

[2] Provincial series accepted for use in U. S. Geological Survey reports shown on next page.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

PROVINCIAL SERIES NAMES ACCEPTED FOR USE IN U. S. GEOLOGICAL SURVEY REPORTS

Series	Age	Region
Gulf	Late Cretaceous	Texas, Louisiana, Oklahoma, Arkansas, Mississippi, and Alabama.
Comanche	Early and Late Cretaceous	
Shasta	Early Cretaceous	California and Oregon.
Ochoa	Permian	Texas and New Mexico.
Guadalupe	do	Do.
Leonard	do	Do.
Wolfcamp	do	Do.
Virgil	Late Pennsylvanian	Arkansas, Oklahoma, Kansas, Missouri, Nebraska, and Iowa.
Missouri	do	
Des Moines	Middle Pennsylvanian	
Atoka	do	
Morrow	Early Pennsylvanian	
Chester	Late Mississippian	Indiana, Kentucky, Tennessee, Illinois, Iowa, Missouri, Arkansas, Oklahoma, and Kansas.
Meramec	do	
Osage	Early Mississippian	
Kinderhook	do	
Cayuga	Late Silurian	New York and Michigan.
Niagara	Middle Silurian	Do.
Alexandrian	Early Silurian	Missouri, Illinois, and Michigan.
Cincinnatian	Late Ordovician	Ohio, Indiana, Kentucky, and Tennessee.
Mohawkian	Middle Ordovician	New York.
St. Croixan	Late Cambrian	Iowa, Minnesota, Wisconsin, and Michigan.
Animikie	Precambrian	Michigan, Wisconsin, and Minnesota.
Belt	do	Idaho and Montana.
Glenarm	Precambrian(?)	New Jersey, Pennsylvania, Delaware, Maryland, and Virginia.
Grand Canyon	Precambrian	Arizona.
Grenville	do	New York.
Gunnison River	do	Colorado.
Keweenawan	do	Michigan.
Little Willow	do	Utah.
Llano	do	Texas.
Ocoee	do	Virginia, Tennessee, North Carolina, and Georgia.
Pahrump	do	California.
Yavapai	do	Arizona.

GEOGRAPHIC NAMES

A geographic name is the name of a locality, a geographic feature, or a definite region. It is capitalized; it may be singular or plural. Many names consist of one word, but others contain two or more. The appropriate names for geographic features must be ascertained; they should be used consistently in all reports and on all maps of the Geological Survey; and they must be spelled according to the form prescribed by the Board on Geographic Names for the official use of the United States Government.

In addition to the files of the Board on Geographic Names, maintained by the Office of Geography, Department of the Interior, the following sources are useful for obtaining and verifying geographic names: For names in the United States and for many foreign countries, the published lists of the decisions of the Board on Geographic Names; for inhabited places, the latest United States "Census of Population" and the United States "Directory of Post Offices"; for counties in the States and for names of foreign countries, the Government Printing Office "Style Manual"; for names of geographic features, the latest maps published by the Geological Survey, Bureau of Land Management, Coast and Geodetic Survey, Air Force, and Corps of Engineers, and official State and county maps.

APPLICATION AND VERIFICATION OF NAMES

If reports and maps are compiled with little or no field investigation, previously published names may be the only data available from which the latest and most authentic names may be chosen after careful appraisal. But field investigation usually is the basis for the preparation of a report; such an investigation is one of the most important steps in the compilation of a map, and it should include the evaluation and verification of names, as far as possible.

Whether name data are obtained from published names or from field studies, an author is responsible for ascertaining, applying, and verifying all names that he uses. After he evaluates the available published names to separate authentic names from names that may seem controversial, he should check the tentatively selected names for local usage as to correctness, application, and spelling. Local usage, as indicated on road signs, building signs, and corporate and other boundary signs, should be considered, and usage by local residents must be ascertained. Of the local residents, public officials such as postmasters, county assessors, game and fire wardens, foresters, sheriffs, and county engineers, as well as local historians, usually are excellent sources of name information. If a name for a feature is obtained through conversation, the spelling should be verified, because phonetic spelling is perhaps the commonest source of error. In re-

mote, unsettled, or sparsely settled areas, published material may be almost the only source of information.

AUTHENTIC SPELLING OF NAMES

In areas under study by the Geological Survey the correct spelling should be determined as the work progresses. Names with variations in their spelling should be distinguished from those that can be accepted without further investigation, and no name should be finally accepted until the possibility of error in spelling as well as in authenticity and application has been eliminated.

CONTROVERSIAL NAMES

It is not the responsibility of the author to determine correct form when there is conflict in usage or in spelling. That responsibility is delegated to the Board on Geographic Names. The author's duty is to decide from the evidence which names are controversial and to submit a comprehensive report about them through proper channels for transmittal to the board. In evaluating information on names, considerable judgment must be exercised to differentiate between genuine controversy and minor discrepancy. The fact that a few people may be confused or mistaken about a name is not sufficient grounds, in itself, for considering a name controversial. Publication of a name in an obscure or privately printed paper and its appearance in a different form on a sign or a map also do not form conclusive evidence of controversy. The conflicting usage may be due to ignorance or carelessness.

Names that must be referred to the Board on Geographic Names for a decision include—

1. Names whose dominant local usage—spelling or application—is different from the official version, as represented by a law or statute, the name of a post office, or a previous decision of the Board on Geographic Names.
2. Names that are spelled locally in more than one way.
3. Names whose local spelling differs from the spelling in previously published official maps and reports.
4. Names for which conflicting usage is due to change in property ownership.
5. Conflicting published names for features in sparsely settled areas where local usage cannot be determined.
6. Proposed new names.

Reports on controversial names must contain the recommended name or form of the name, the other names or name variants, a statement of the evidence supporting the recommended form, and a description of the location of the feature. Where local usage is involved, the supporting evidence should include the names, addresses, and

occupations of at least three local residents as authorities for the name recommended. When the extent of a feature is considered controversial, a complete description of the recommended extent shall be given, together with a description of the variations from it.

The reports should be sent through channels to the division chief for transmittal to the Board on Geographic Names, through the chief topographic engineer. The Topographic Division has been designated as the clearing office for the Geological Survey's transactions with the Board on Geographic Names.

PROPOSED NEW NAMES

When it is necessary to propose a name for an unnamed feature, a report on the new name must be submitted to the Board on Geographic Names for approval before publication. The report should contain a description of the location and extent of the feature, and the reasons for the selection of the name, indicating that it is descriptive or is derived from a person or event connected with the history of the area. The suggested name should not duplicate that of a similar feature in the same State, and it should not honor a living person.

Names that are in accepted local use, even though they have never been published, are not considered new names; they should not be submitted to the Board on Geographic Names for approval.

CAPITALIZATION OF GEOGRAPHIC NAMES

Geographic names may include proper nouns, common nouns, and adjectives, and such words are capitalized:

Little Prickly Pear Creek	Panama Canal
Red Rock River	Meigs Bridge
Big Hole Basin	Alva B. Adams Tunnel
Upper Madison Canyon	Parker Dam

The adjectives "little," "upper," "red," and "big" are capitalized in some of the geographic names just listed because they are essential parts of the names. The words "canal," "bridge," "tunnel," and "dam" ordinarily are lowercased, and the terms in which they are generally used are not considered formal geographic names. However, they must be capitalized in the names of the manmade features listed above because the names have been applied by acts of Congress or State legislatures or have been legally established by use in contracts for building these features.

Some geographic names include the capitalized article as a part of the name: The Dalles, The Weirs, The Dells, El Paso, Los Angeles, La Jolla, Las Cruces. Ordinarily, however, articles and short prepositions in multiple-word names are not capitalized: Lake of the Woods, Isle of Pines.

Names of definite regions, localities, or geographic features are capitalized in both the singular and the plural:

Allegheny Front
Andromeda Cone
Atlantic Coastal Plain
Bighorn Basin
Blue Ridge
Canal Zone
Cascade Range
Catahoula Parish
Colorado Plateau
Continental Divide
Crow Indian Reservation
Dennison Township
Driftless Area
Eastern Shore (Maryland and Virginia)
Equatorial Countercurrent
Fall Line, Fall Zone
Front Range
Great Lakes
Gulf States, Central States
Half Dome
High Plains
Isle of Pines
Lower Town Landing (New York)
Monarch Geyser
Mount Rainier
Niagara Falls
North Atlantic States
Pacific Coast States
Potomac and James Rivers
Puget Sound
Rio Blanco and Moffat Counties
San Joaquin Valley
Skyline Drive
Tidal Basin (District of Columbia)
Twin Calderas
Theodore Roosevelt Pass
Upper Peninsula (Michigan)
the West, the Southwest
Western States

The words "basin" and "valley" are not capitalized when used with river names: Potomac River valley, Missouri River basin. An exception is the Red River Valley of song and story. "Valley" is capitalized when it is part of the recognized name of a valley, whether or not the proper name of the valley coincides with that of one of the rivers in the valley: Santa Maria Valley, Paradise Valley, Lehigh Valley, Sacramento Valley, Central Valley. "Basin" is capitalized when it is part of the name of a geographic feature that is definitely basin shaped: the Bighorn Basin, for example, as given in the preceding list.

Such terms as "district," "area," "region," and "province" are generally regarded as common nouns not forming a part of the proper name and are therefore not capitalized. When such a term immediately precedes a State name, the name of the State should be spelled out. Examples are as follows:

Adirondack province
Basin and Range province
Castle Dome area
Silverton quadrangle, Colorado
Breckenridge district
Moores Hill district, Kentucky
Yukon-Tanana region

Where a State name follows a capitalized name, it is abbreviated, as in "Sacramento Valley, Calif."

DISTINCTION BETWEEN GEOGRAPHIC AND GEOLOGIC NAMES

Geologic terms such as "formation," "anticline," "syncline," "dome," "fold," "fault," "coal field," "mine," "claim," and other

similar terms are regarded as common nouns not forming a part of the proper name. Examples are as follows:

Matchless mine
Killarney claim
Book Cliffs coal field
Hugoton gas field
East Texas oil field
Miami Springs–Hialeah well field (water)
Cincinnati anticline
Lagarto formation
Nacimiento uplift
Vermejo Park dome
Williams Range fault
Currelly vein
Lillie Belle prospect
Santa Maria basin (structural basin)

Sections on geography and physiography and descriptions of topography should be written in exact terms, with careful differentiation between geographic and geologic names.

One author might write incorrectly: "The Seneca District coincides with a late Tertiary and early Pleistocene depositional basin—the Seneca Basin. * * * The Seneca Valley itself is a syncline." Another writes: "There are two major alluvial plains in the area, one in the Seneca Valley. * * * The Seneca Plain extends from Smith Point * * * to the Atlantic Ocean. * * * The Seneca River proper traverses the full length of the Seneca Alluvial Plain."

The formal geographic names in the above examples are "Seneca Valley" and "Seneca River"; "district," "basin," "plain," and "alluvial plain" are common nouns and should be lowercased.

FOREIGN GEOGRAPHIC NAMES

Foreign geographic names that are used in Geological Survey reports and on Survey maps are spelled according to the forms officially used in the country, if it uses a roman alphabet. The place names for nonroman alphabets and nonalphabetic characters are transliterated and spelled according to forms established by the Board on Geographic Names. Geographic names for many countries are available in pamphlet form as decisions of the board, and the Office of Geography is able to supply, through the Topographic Division, the recommended names from its files for many places for which decisions have not been made.

DIACRITICAL MARKS

Diacritical marks, such as the tilde (cañon), dieresis or umlaut (Korcë, Nürnberg), slash (Røros), macron (Kyūshū), cedilla (Iaşi), inverted cedilla (Dąbrowa), grave (Asmères), acute (Orléans), soft sign (Arkhangel'sk), circumflex (Nîmes), superior dot (Skarżysko Kamienna), and others, should be used as they are in the language of the country. The utmost care should be taken to use them correctly.

Diacritical marks are not used on anglicized words of foreign origin (G. P. O. "Style Manual," 1953 ed., list on p. 55); on place names

containing both foreign and English words (Santa Maria Valley, Dona Ana County, Canon City, Mexico City); or on names of foreign origin applied to places in the continental United States, even if the foreign names are not mixed with English words (California, Los Angeles). In reports on a territory or possession of the United States whose official language is not English, place names and other foreign words are written in conformity with precedences established by the Board on Geographic Names but in general are written as they are used in the native language.

USE OF FOREIGN-LANGUAGE GEOGRAPHIC TERMS

No attempt should be made to translate geographic names of foreign-language origin into English. Many geographic terms in reports written in languages other than English are easily recognizable in text, particularly if the term is shown on the index map or other maps accompanying the paper—for example, volcán for volcano; rivière for river; bahía for bay; sierra, cordillera, or montañas for mountains; isla or isola for island; punta or puntan for point; golfo for gulf; lago, lac, or lak for lake; laguna for lagoon; and many others.

Geographic terms that are not recognizable at a glance may be explained briefly in text as—

> During the rainy season water * * * may be obtained from the Río Jaguaribe or the creek Riacho Livramento.
>
> North of the river stands the peak Cerro Gordo * * *. Equally great relief is found * * * south of Cerro Huehuento (altitude 3,150 meters).
>
> Thailand is divided into 70 changwats, or counties. Each changwat is subdivided into amphoes, or districts. When an amphoe is small it is called a king amphoe (subdistrict) * * * which is subdivided into tampons, or villages.

If the report contains many unfamiliar geographic terms a short list may be inserted in the text or on the map.

An explanation of a few geographic terms may be necessary, but to oversimplify these terms by translating every word into English is undesirable. Furthermore, there is an increasing tendency to use foreign terms for which there is no need to know the English meanings.

Many countries, particularly in Europe, do not use a term for river, speaking of a stream simply as the Volga, Elbe, Loire, or Rhone. In Portuguese and Spanish the word for river precedes the name of the stream, as in the Portuguese names Rio Madeira and Rio Negro and the Spanish names Río del Oro and Río Ebro. Some languages, however, have terms for streams that need to be explained.

Names of principal foreign countries are always given in the conventional form approved by the Department of State and the Board on Geographic Names. They are listed in the Government Printing Office "Style Manual," for convenient checking. Political subdivisions of each country should be given in the full official form (or

the short form); for example, Provincia del Oriente, or Oriente; Estado de Durango, or Durango; Departamento Cabañas, or Cabañas.

Names of cities, too, generally should be given as they are spelled in the country. México, D. F. (Distrito Federal) should be as easily understood as Washington, D. C., but the form Mexico City has been so widely used that it is an accepted conventional form. However, "city" should not be added to the names of other cities in Latin American countries; the official name in the language of the country should be used, as Ciudad Trujillo, Ciudad Juárez.

CONVENTIONAL GEOGRAPHIC NAMES

Certain world cities and geographic regions for many years have had English spellings that have become so well known as to be conventional names. Among those most often used are the following, with the official name in parentheses:

Anatolia (Anadolu)
Archangel (Arkhangel'sk)
Athens (Athínai)
Bavaria (Land Bayern)
Belgrade (Beograd)
Black Forest (Schwarzwald)
Brittany (Bretagne)
Brussels (Bruxelles, Brussel)
Bucharest (Bucureşti)
Canary Islands (Islas Canarias)
Copenhagen (København)
Corsica (Corse)
Crete (Kríti)
Dunkirk (Dunkerque)
Etna, Mount (Monte Etna)
Faeroe Islands (Föroyar)
Florence (Firenze)
Galapagos Islands (Archipiélago de Colón)
Gascony (Gascogne)
Geneva (Genève)
Java (Djawa)
Kamchatka Peninsula (Poluostrov Kamchatka)
Lake Baikal (Ozero Baykal)
Leghorn (Livorno)
Milan (Milano)
Moscow (Moskva)
Munich (München)
Nanking (Nan-ching)
Naples (Napoli)
Normandy (Normandie)
Peking, Peiping (Pei-p'ing)
Rome (Roma)
Saxony (Land Sachsen)
The Hague ('s Gravenhage)
Transylvania (Transilvania)
Ural Mountains (Ural'skiy Khrebet)
Venice (Venezia)
Vienna (Wien)
Warsaw (Warszawa)
Yangtze River (Ch'ang Chiang)

For features common to two or more countries or for areas having different languages, local official names, and conventional names, usually the conventional form is used. Some examples are—

Amazon River
Amur River
Balkan Mountains
Bohemian Forest
Brenner Pass
Dragons Mouth
Gulf of Paria
Hindu Kush
Khyber Pass
Mount Everest
Persian Gulf
Pyrenees

Only the conventional name is used for features common to many countries such as the oceans, the Mediterranean and Caribbean Seas,

long rivers like the Danube, Salween, and Congo, and mountain ranges such as the Andes, Caucasus Mountains, and Himalayas.

SELECTED REFERENCES

U. S. Geographic Board, 1933, Sixth report of the United States Geographic Board, 1890–1932: p. 3–75.

U. S. Geological Survey, 1953, Obtaining name information, Chap. 3 A 10 *of* Topographic instructions: Research and Tech. Control Br., Topog. Div.

——— 1954, Glossary of names for topographic forms, Chap. 6 A 3 *of* Topographic instructions: Research and Tech. Control Br., Topog. Div.

SIGNIFICANT FIGURES

Numerical data used in solving practical problems are seldom exact. The numbers are usually rounded off and consequently represent approximations that are true within certain limits of error. Not only are the data approximate but, often, so are the mathematical operations involved in the calculations. In numerical computations it is unnecessarily time consuming to use more digits than are essential. The reporting of data with too many or too few digits may be misleading as to accuracy. To avoid surplus digits, numbers should always be rounded off at the point where the figures cease to have a real meaning. Careful consideration, therefore, should be given to the significant digits involved in each measurement as well as the operations performed on it. Conversely, the number of significant figures is sometimes unnecessarily reduced as a result of choosing the least desirable of several possible methods of calculation.

The principles and methods of use of significant figures discussed here are intended not to replace, but rather to supplement, those which have been worked out carefully by some units of the Geological Survey for specific types of presentation, such as data on streamflow and on geodetic observations.

As a general rule, the number of significant figures resulting from any calculation involving simple arithmetic operations on measured quantities, such as addition, subtraction, multiplication, and division, should not exceed the number of significant figures of the least accurate number entering into the calculation. In performing the calculation itself, one more significant figure may be retained in the more accurate numbers than are present in the least accurate number.

The digits 1 through 9 are always significant digits regardless of their position in a number. The digit 0 is significant when it occurs between other significant digits. It is never significant when placed at the left of a number to fix the location of the decimal point. At the right of a number it is significant if it indicates actual accuracy, but not if it is used only to complete a rounded number. For example, the number 0.0046 has only 2 significant figures, but 4,103 has 4 significant figures. In a number like 53,200 it is difficult to determine

the number of significant figures because the 2 zeros at the end may have actually been determined by experimental means. To remove this ambiguity the number may be written in the form 5.3200×10^4 to show 5 significant figures, or 5.32×10^4 to show 3. Nonsignificant zeros should never be used at the right of the decimal part of a number. In tabulating data, an alternative is to list only the significant figures, the superfluous zeros being absorbed in the general heading, as follows:

Specimen	*Temperature* ($°C \times 10^3$)
A	1. 4
B	2. 0
C	1. 8
D	1. 2

ROUNDING OFF NUMBERS

A consistent procedure should be followed in rounding off numbers to n significant figures. All digits to the right of the nth digit should be discarded, as illustrated in the following 6 examples of rounded numbers each of which has only 3 significant figures:

Example No.	*Original number*	*Rounded number*
1	0.32891	0.329
2	47, 543	47, 500
3	11.65	11.6
4	22.75	22.8
5	18.05	18.0
6	18.051	18.1

If the first of the discarded digits is greater than 5, add 1 to the nth digit (example 1). If the first of the discarded digits is less than 5, leave the nth digit unchanged (example 2). If the first of the discarded digits is 5 and all the following digits are zero, round off to the nearest even number (examples 3–5). If the 5 is followed by any of the digits 1 to 9, add 1 to the nth digit (example 6).

Occasionally, where the difference between successive numbers is more important than the total or average, it may be desirable to round consistently in one direction all numbers in which the first dropped digit is 5 followed by zeros only, instead of rounding to the nearest even number.

In presenting numerical data, only those digits that convey actual information should be given. The last digit should represent the uncertainty in the data. Unless stated otherwise, it is generally assumed that the last significant figure is uncertain by one unit. To illustrate, if the length of a cylindrical core is given as 3.12 cm, it is implied that the true length is 3.12 ± 0.01 cm and is thus somewhere between 3.11 and 3.13 cm. If the uncertainty in the last figure is appreciably different from 1 unit, attention should be called to it, such as by expressing the measurement as 3.12 ± 0.03 cm.

ABSOLUTE AND RELATIVE ERRORS

The absolute error of a number or measurement is usually defined as the numerical difference between the true value and the approximate value as given by the number or measurement. The relative error can be defined as the absolute error divided by the true value of the quantity. The true index of a measurement is expressed by the relative error, which in turn is indicated by the number of significant figures required to express it. It is for this reason that the number of significant figures is so important in representing measured or computed quantities.

The following example illustrates the difference between absolute and relative errors. It is assumed that the length of a carefully prepared and polished core of rock 2 inches long has been measured to the nearest thousandth of an inch and that a mile of railroad track has been measured to the nearest foot. The absolute errors are 0.0005 inch for the core and 0.5 foot for the track, whereas the relative errors are respectively—

$$\frac{0.0005}{2}=\frac{1}{4{,}000} \text{ and } \frac{0.5}{5{,}280}=\frac{1}{10{,}560}$$

Obviously, the track measurement is relatively better.

ARITHMETIC OPERATIONS

A simple arithmetic operation such as addition or multiplication may affect the number of significant figures in the result. In addition and subtraction the location of the decimal point plays an important role in the retention of significant figures. The general rule can be illustrated thus: Suppose it is desired to add the numbers 120.632, 8.14, 980.3, and 1,401.0023, each number being correct to its last figure. As the third number listed is correct only to the first decimal place, it is meaningless to retain more than two decimal places in the other numbers. Consequently—

$$\begin{array}{r} 120.63 \\ 8.14 \\ 980.3 \\ 1{,}401.00 \\ \hline 2{,}510.07 \end{array}$$

and the result is rounded to 2,510.1. Note that only one decimal place is retained in the sum, and that the number of significant figures in the sum is less than the number of significant figures in two of the original numbers. Note also that the procedure of rounding off applies to measurements, but not to whole numbers that are correct to the last digit. If the whole numbers in the example given

above applied to individual persons or digits and represented counts that were correct to the last digit, they would be shown thus:

$$\begin{array}{r} 120 \\ 8 \\ 980 \\ 1{,}401 \\ \hline 2{,}509 \end{array}$$

and the total would not be rounded off.

If small numbers are added to (or subtracted from) large numbers of limited accuracy, the total should retain no more significant figures than are justified by the accuracy of the larger numbers. For example, in adding 356,000 (good to only 3 figures) and 1,420 (good also to 3 figures), the sum is 357,000, not 357,420. The figures that are dropped are within the limits of error of the larger number and are meaningless in the sum. By the same reasoning, the addition of a very large group of numbers of limited accuracy cannot produce a total more accurate than the respective items. Therefore, if several hundred objects have been weighed individually with an accuracy of 3 figures, the total weight of all the objects should be rounded off to 3 significant figures.

In subtraction the number of significant figures in the difference may be considerably reduced if the numbers are close to each other in numerical value. Suppose 0.1189 is subtracted from 0.1204. The difference is 0.0015, which contains only 2 significant figures. The following practical problem involving subtraction and division will illustrate the point further.

A deep hole was drilled. As a consequence of drilling, the temperature at a given point in the hole increased and then began to decrease. As the hole cools, the temperature should eventually reach equilibrium. The equilibrium temperature can be computed from the following relationship:

$$T_e = \frac{T_1 \times T_3 - T_2^2}{T_1 + T_3 - 2T_2}$$

At some specific point in the hole, T_1, T_2, and T_3 represent temperature measurements separated by equal intervals of time, and T_e is the equilibrium temperature.

The following data were taken:

t (Time, in days after drilling)	T (Temperature, in degrees centigrade)
261	$17.613 = T_1$
275	$17.583 = T_2$
289	$17.562 = T_3$

$$\text{And } T_e=\frac{17.613\times17.562-17.583^2}{17.613+17.562-2(17.583)}=\frac{309.320-309.162}{35.175-35.166}=\frac{+0.158}{+0.009}=20.$$

Although the original data are correct to a thousandth of a degree, the final result is correct to the first figure only (tens of degrees) because the denominator has only one significant figure. It would be easy, unwittingly, to calculate the equilibrium temperature incorrectly as 158/9=17.6° or 17.556°. Such answers would not be justified because of the small denominator. This formula is useless for this calculation; therefore, another method should be used to calculate the equilibrium temperature. A possible alternative might be to select temperature measurements separated by unequal intervals of time.

In the multiplication or division of two or more approximate numbers of different accuracies, the more accurate numbers should be rounded off so as to contain one more significant figure than the least accurate number. In this procedure, the error of the product is due almost entirely to the error of the least accurate number. Therefore, the final result should be given to as many significant figures as are contained in the least accurate number, and no more. As illustrations, two calculations may be given:

$$103.24\times0.0081=103\times0.0081=0.83$$

$$\frac{56.3}{2.23612}=\frac{56.3}{2.236}=25.2$$

In computing with logarithms no more decimals need be retained in the mantissa of the logarithm than the number of significant figures in the numerical factors that enter the computation. Thus, log 352.3= 2.5469. It is sometimes easier to use logarithms directly from the tables without rounding off, but the results of computation should never be presented as being more accurate than the original data.

EXAMPLES OF MISUSE OF SIGNIFICANT FIGURES

It is impossible to obtain a result more accurate than the data used. Thus the number of significant figures of the result cannot be greater than is justified by the least accurate number entering into the calculation. In spite of this rule, there are many examples of published data that contain an incorrect number of significant figures.

It is not unusual for estimates of ore reserves to be carried to as many as 6 significant figures—for example, 123,415 tons. To calculate the tonnage, the estimated volume, which is usually determined from drill-hole information, is multiplied by the density of the ore. At best, the volume can be determined accurately to only 3 significant figures, and probably to no more than 2. The density of the ore may be correct to 2 significant figures. Consequently, the calculation of the estimated

tonnage can produce no more than 2 significant figures. The figure in the foregoing example should be given as 120,000 tons.

In a recent periodical, the depth to a geologic structure, as computed from gravity determinations, was given as 13,016 feet. This figure was calculated on the assumption of a density contrast for the ore body good to only 2 significant figures; the figure should have been given as "about 13,000 feet."

Linear correlation coefficients, as given in another publication, were determined for samples of crude oil that had been analyzed spectrographically for vanadium and nickel and chemically for uranium. The individual determinations were accurate to no more than 3 significant figures and probably no more than 2. Yet correlation coefficients were presented to as many as 5 significant figures.

Another illustration concerns published results of chemical analyses of water. These were tabulated in parts per million to as many as 6 significant figures, whereas the analytical procedures justified only 2 or 3. Instructions in the Survey state specifically that for concentrations of more than 1,000 ppm (parts per million) only 3 significant figures should be reported, and for concentrations between 10 and 1,000 ppm only whole numbers should be reported. However, in the analyses mentioned, typical numbers in parts per million were 1,061.39 and 1,029.73 for SO_4, 880.90 for Na, and 205.62 for Cl; stated according to the Survey rule, these would be 1,060 ppm, 1,030 ppm, 881 ppm, and 206 ppm.

In some published stratigraphic measurements, such as the thicknesses of rock formations, an unrealistic accuracy is indicated. For example, the thickness of a sedimentary formation of Tertiary age, whose top and bottom are not well defined and thus are somewhat uncertain, was reported as 14,633 feet; a more acceptable figure would be "about 15,000 feet." Calculations of the thickness of such rock units based upon measurements of strike and dip along a measured traverse inevitably contain many uncertainties—exact amount and direction of dip, magnetic declination, nature of exposure, and others—which are almost impossible to evaluate, and which limit the acceptable value to a few significant figures.

Frequently certain field measurements, some of which are relatively crude, are improperly given to a greater number of significant figures than are justified by even the most refined laboratory methods. In these, as well as in laboratory measurements, care should be taken to use as many significant figures as are justified, but no more.

QUOTATIONS

Responsibility for the accuracy of quotations rests with the author; they will not be verified in editorial review. In reprinted matter the

exact words of the original should be preserved, but it is not necessary to reproduce typographical errors or details of printer's style such as spelling, capitalization, and punctuation, except in quotations in which, for obvious reasons, quaintness or exactness of form should be preserved. Omissions in quoted matter should be indicated by three asterisks. Errors sometimes are made in copying printed matter. The typed copy of every quotation should be compared carefully with the original.

Ordinarily quotations from foreign languages are translated into English; if it is desirable to present the material in its original language, both the original and a translation should be given.

CITATION OF PUBLICATIONS

GENERAL PRINCIPLES

In nearly all reports it is necessary or desirable to refer to the work of others on the same or related subjects. If only 1 or 2 publications are cited, and if the references in the text to these publications are few, the citations may be made in footnotes. However, the usual form is to place all citations of published material under appropriate headings at the end of the report or, in some comprehensive reports, at the end of the chapters; brief references to these citations are given in parentheses in the text. The headings "Literature cited," "References cited," or "References" are used if all the publications listed are referred to in the text. The headings "Selected bibliography" or "Selected references" are used if the list is more extensive and "Bibliography" if it is exhaustive.

Open-file reports of the Geological Survey are a medium of dissemination of information to all interested persons, and hence they represent a form of publication. Therefore, these reports are included in lists of publications at the end of Survey reports. The lists that include such citations are headed "References cited," "References," or "Selected references." Open-file reports are cited also in the bibliographies on commodities; they are not cited, however, in the bibliographies of North American geology.

An oral or written communication is referred to in the text by placing in parentheses "oral communication" or "written communication," accompanied by the name of its author and, if necessary, by the date. In this category are included the following: (a) Data and opinions given orally; (b) correspondence; (c) file data, including memorandums, manuscripts, maps, and notes; (d) unpublished college theses; and (e) manuscripts that are in preparation. If there is good justification, an author may include in the text a reference to an unpublished thesis by giving there its title, name of its author, and name of the institution. For a thesis to be so cited it must be available to

the public; such citations should be very few because unpublished theses generally are not conveniently available. The "in preparation" status of a manuscript is not ended at the date of its approval by the Director. It is ended when a manuscript to be published by the Survey is sent to the printer or when a manuscript to be published outside the Survey is accepted for publication; thereafter, it may be cited as "in press" in bibliographic or reference lists. These designations should be verified just before page proof is returned to the printer. "In press" is placed in parentheses after the name of the publisher and series.

The titles of books, articles, or reports that are quoted in the text are enclosed in quotation marks, and their first word and all important words are capitalized—"Webster's New International Dictionary," second edition; United States Government Printing Office "Style Manual"; "Geologic Names of North America Introduced in 1936–1955," by Wilson, Sando, and Kopf (1957); "Suggestions to Authors of the Reports of the United States Geological Survey," fifth edition, 1958.

Footnote references are indicated in the text by a "shelf" (_/) and the footnote is typed just below the line in which the reference mark appears and is set off by rules above and below. The "shelf" in the text is placed just after the name of the author cited or, if the name is in the possessive form, after the noun following it ("Gilbert's theory_/"). Footnotes should not be numbered by the author; the numbering will be done by the editor after all eliminations and additions have been made, just before the manuscript goes to the printer.

References are indicated in the text by placing within parentheses the author's last name (and initials if there is any chance of confusion) followed by a comma, the year of publication followed by a comma, and the specific pages or illustrations—for example, "Production of lithium was begun at Searles Lake, Calif., in 1938 (Mumford, 1949, p. 513)." If the author's name naturally falls in the sentence, then only the date and the page reference are included within parentheses, as in "Schaller (1911, p. 49) reported that the type specimen of this material contained 3.21 percent Li_2O." If there is reference to several publications of an author in the same year, indicate them by the letters a, b, c, after the year, as in "(Reeside, 1927a, p. 5–7)." If a paper has two authors, the material within the parentheses should have both authors' names, as in "Ephesite contains as much as 3.80 percent Li_2O (Schaller and Carron, 1952, p. 301)." If it has three or more authors, the reference may be to the first-named author "and others," as in "(Palache and others, 1951, p. 825)," instead of "(Palache, Berman, and Frondel, 1951, p. 825)," if there is only one reference that can be so cited.

The order of items of citation in bibliographic lists is as follows:

1. Name of author, the surname first and initials or given name next, followed by a comma.
2. Year, followed by a comma. Words "no date" in brackets may be used if no year is given on publication. In the "Bibliography of North American Geology" and the commodity or other special-purpose bibliographies and compilations of abstracts, the year may be placed at the end of the citation.
3. Title of work cited, followed by a colon.
4. Name of periodical or series of publications in which the paper cited appears; volume or number in arabic numerals; exact pages, plates and figures (if an important part of the report or significant to the purposes of the bibliography); the place of publication and publisher's name if necessary to identify the publication. For books, after the colon, give place of publication; publisher's name; pages; and plates and figures if important or significant. Ordinarily only the final pagination, omitting count of introductory pages, is used to indicate the extent of the text. Complete paging is required for chapters and articles in periodicals, and is desirable though not required, for independent publications, such as books and professional papers, bulletins, or water-supply papers that are not chapters. The Government Printing Office is given as the publisher of reports issued by special or temporary bodies but is ordinarily not listed in citations of reports issued by permanent Federal agencies.

The citations are listed in alphabetical order by the name of the author and chronologically under the author, the oldest publications first. All publications of an individual author are listed first, then those written with coauthors are listed in alphabetical and chronological order, each grouping of authors being considered a unit. After the first listing of an author or group of authors, a dash is used instead of repeating the name or names; one dash takes the place of all the names in the previous citation. (See examples 4, 36, and 42; p. 119–121.) The dash is not followed by a comma; no space is left between the dash and the year.

If the author of the work cited uses only one given name, it should be written in full, as Butts, Charles. If the author uses more than one given name, initials may be used in the citation if the name in that form uniquely identifies the author. For authors with initials or names that might cause confusion, it is better to give the full name in the citation.

If no author is named, the organization should be listed as author. Thus, some water-supply papers should be listed under U. S. Geological Survey. (See also examples 20, 37, and 38.)

The selection of the last name under which the citation is to be listed may be difficult, especially in foreign names. The author's own usage, if ascertainable, or the custom of his country should be followed. Otherwise, in general, if there is a prefix that is a definite article (La, Le, L'), or a preposition and an article forming one word (Dall', Du, Della, Lo), the prefix is considered to be part of the surname. If the prefix is a preposition standing alone (de, van, da), it is not considered to be part of the surname. In anglicized names, the prefix is considered to be a part of the surname. In some countries compound names are common. These should ordinarily be cited under the first of the compound names. (See examples 13–15, 21, 22, 52, and 53.)

If the date of publication differs from the date given in the imprint it is desirable to give both dates, especially if questions of priority are involved. The imprint date follows the author's name and the supplied date is placed at the end of the citation, in brackets. Thus, if a Survey bulletin bears the date 1955 on the title page, but was not released until 1956, the citation should include 1955 after the author's name and 1956 in brackets at the end. (See examples 23 and 27.)

Ordinarily the title should be cited completely and without changes, except for correction of obvious typographical errors; occasionally, words may be added in brackets for the sake of clarification. In English, only the first word, proper nouns, and proper adjectives should be capitalized, but in other languages the national practice should be followed. Diacritical marks are often omitted in display type but should be used correctly in citations. Titles in foreign languages may be followed by a translated title in brackets.

In citing chapters of the Survey's series of "contributions" to general geology, economic geology, and hydrology (or similar collections of separate papers), the author and title of the particular paper are given, not the title of the series. (See example 3.) However, if a paper is published in several parts, and each part has a distinctive title in addition to an overall title, both should be given in the citation. (See examples 44 and 45.)

Names of serial publications usually are abbreviated in citations. The abbreviations used must be such that the readers of the report can readily identify or locate the publication cited. In bibliographies or compilations of abstracts in which the abbreviations used are explained in an introduction, it is permissible to use very brief forms, but these should not be taken as examples of the general practice to be followed in lists of literature or references cited in reports.

By following the rules given below, and by analogy with the examples given in the list of typical forms (p. 119–122), a satisfactory abbreviation generally can be determined. Care should be taken to use exactly the same abbreviation throughout any one report.

Words that are usually abbreviated and their abbreviated forms are given on pages 111–114. Combined words ending in these words also may be abbreviated (for example, astrophysical—astrophys., geochemical—geochem.) and foreign equivalents of these words, in addition to those shown in this list, may be abbreviated in the same way (botanique—bot.). No other words should be abbreviated. One-word titles should not be abbreviated even though the word is abbreviated in other longer titles. Words such as "the," "a," "of," "on," and sometimes "and" (or their equivalents in foreign languages) may be omitted. "State of," as in "State of California," also may be omitted. All others should be written in full. Ordinarily all words in the journal title except those just mentioned are included in the abbreviation, and if the title is not distinctive the name of the city, State, or country where the journal is published is added in brackets after the name of the organization or serial.

Names of organizations are placed first in the abbreviated form. Otherwise the word order in the abbreviation is the same as in the full title. In citing publications of governmental organizations, the name of the country, State, or city should be given first. Use "U. S." in U. S. Geological Survey or in names of other Government bureaus, offices, or departments, and U. S. S. R. or SSSR, but spell out names of all other countries, States, provinces, and cities. In names of State universities, the State name should be first. In citing publications of nongovernmental organizations the name of the organization is placed first in the abbreviation, but the word order in the name is not changed (thus Japan Geol. Survey Bull., but Geol. Soc. Japan Jour.; Canada Geol. Survey Mem., but Geol. Assoc. Canada Proc.; California Univ. Pub. Geol. Sci., but Univ. Grenoble lab. géologie fac. sci. Travaux).

In citations of the proceedings or other publications of congresses, conferences, and similar meetings, place the name of the congress or conference first, then the number of the meeting, if any, the place (city, or city and country) and date (year) of the meeting, and finally the title of the publication (Internat. Geol. Cong., 19th, Algiers 1952, Comptes rendus). If there is more than one meeting in a calendar year, the exact dates of the meeting should be given.

Capitalization in the abbreviation follows that in the full title, except that in the inverted-word order the first word must be capitalized even though it may not be capitalized in the original. Punctuation in an abbreviation should be kept to a minimum: periods after abbreviated words, brackets around supplied words, and commas only where necessary for clear understanding of inverted material.

In citations of foreign publications, use "v.", "no.", "pt.", and "p." rather than the foreign term. The table below shows the common bibliographic terms and some of their foreign equivalents:

	Volume	*Part*	*Number*	*Page*
Bohemian (Czech)	svazek kniha	část	číslo	strana
Danish	bind aargang	del	nummer hefte	side
Dutch	boekdeel jaargang	aflevering deel	nummer	bladzijde pagina
French	volume tome année	part fascicule	numéro	page
German	Band Jahrgang	Teil	Nummer Heft	Seite
Greek	τόμος	μέρος	αριθμός	σελις
Hungarian	kötet	rész	szám	lap
Italian	volume anno	parte	numero	pagina
Norwegian	bind	del	nummer hefte	side
Polish	rok książka tom	część	numer	stronca
Portuguese	volume tomo anno	parte	numero	pagina
Russian	том	часть	выпуск номер	страница
Spanish	volumen tomo año	parte	número	página
Swedish	volym band	del	häfte nummer numro	sida page
Turkish	cilt	cüz	sayi	sahife

If the serial has no distinctive numeral designation of volume other than the year of publication, the date should be used in place of the number of the volume, as well as after the author's name.

If a volume of a serial is paged continuously, it is not necessary to cite the particular number, but if pagination starts afresh with each number it is obvious that "no." must be included. For recent issues, which may still be unbound in libraries, it is a convenience to the reader to include the number in the citation, even for those journals in which the pagination is continuous.

Citations of publications issued in sections or series should include the identifying number or letter of the section or series if the same volume number appears in more than one series (Am. Jour. Sci., 4th ser., v. 1, or New Zealand Jour. Sci. and Technology, Sec. B, v. 35).

ABBREVIATIONS USED IN CITATIONS

The abbreviations used in the citation of publications are listed below. The words capitalized in this list must always be capitalized. The capitalization of other words depends on their place in the citation and their use in the publication cited.

aardrijkskundig	aardrijksk.
Abhandlung	Abh.
abstract(s)	abs.
Abteilung	Abt.
academia, académie, academy	acad.
accademia	accad.
administration, administrative	adm.
advancement, advanced	adv.
affinis	aff.
agricultural	agr.
Akademie	Akad.
akademie, akademiya	akad.
allgemeine	allg.
American	Am.
analytic(al)	anal.
angewandte	angew.
annotated	annot.
annual	ann.
anorganisch	anorg.
-anstalt	-anst.
anthropological	anthropol.
Anzeiger	Anz.
appendix	app.
applied, appliqué	appl.
approximate(ly)	approx.
April	Apr.
Arbeiten	Arb.
årbok	årb.
archaeological	archaeol.
archeological	archeol.
årsskrift	årssk.
article	art.
association	assoc.
astronomic(al)	astron.
August	Aug.
auxiliary	aux.
avancement	av.
avdelingen	avd.
avhandlingar	avh.
Beilage	Beil.
Beitrag, Beiträge	Beitr.
Bericht	Ber.
bibliographic(al)	bibliog.
biennial	bienn.
biographic(al)	biog.
biologic(al)	biol.
boletim, boletín	bol.
bollettino	boll.
botanic(al), botanisch	bot.
branch	br.
building, -s	bldg., bldgs.
bulletin	bull.
bureau	bur.
catalog, catalogue	cat.
Centralblatt	Centralbl.
chairman	chm.
chapter	chap.
chemical	chem.
chimique	chim.
ciencia(s)	cienc.
científica(s)	cient.
circular	circ.
class, classe	cl.
classification	classn.
collection(s)	colln.
college	coll.
commission, committee	comm.
communication(s)	commun.
Compañía	Cía.
comparative	comp.
conference	conf.
Congress, Congressional	Cong.
conservation	conserv.
consolidated	consol.
contribution(s)	contr.
cooperation, cooperative	coop.
crystallographic(a)	cryst.
December	Dec.
Denkschrift(en)	Denkschr.
department, departamento, département	dept., dépt.
development	devel.
dissertation	dissert.

distribution	distrib.
district	dist.
division, divisão, división	div.
document	doc.
ecologic(al)	ecol.
economic(al)	econ.
edition, edited, editor, -s	ed., eds.
educational	educ.
electric(al)	elec.
engineering	eng.
entomologic(al)	entomol.
equivalent	equiv.
Erläuterungen	Erläut.
examination	exam.
except	exc.
expedition	exped.
experiment	expt.
explanation, explanatory	expl.
exploration	explor.
extension	ext.
extract, extracted	extr.
facsimile(s)	facsim.
faculty	fac.
February	Feb.
figure, -s	fig., figs.
fisiche, fisisk	fis.
fizicheskiy	fiz.
fiziograficheskiy	fiziog.
folleto	fol.
foraminiferal	foram.
förening	fören.
förhandlingar	förh.
formation, -s	fm., fms.
Fortschritte	Fortschr.
foundation	found.
frontispiece	front.
fysiografiska	fysiog.
gazzetta	gazz.
gazette	gaz.
geneeskunde	geneesk.
general, générale	gen., gén.
genootschap	genoot.
geochemical	geochem.
géodésique	géod.
geodetic, geodaetisk, geodeticheskiy	geod.
geographic(al), géographique	geog., géog.
geologic(al), geologisch, geológica, géologique	geol., géol.
Geological Survey	Geol. Survey
geophysical	geophys.
Gesellschaft	Gesell.
giornale	gior.
government	govt.
handbook, Handbuch	handb., Handb.
historic(al)	hist.
hüttenmännisch	hüttenm.
hydrographic	hydrog.
hydrologic(al)	hydrol.
illustrated, illustration(s)	illus.
imperial	imp.
including, inclusive	incl.
Incorporated	Inc.
independent	indep.
indeterminate	indet.
industrial	indus.
information	inf.
institute, institution	inst.
internacional	internac.
internal	int.
international	internat.
introduction	introd.
investigación, investigation(s)	inv.
irrigation	irrig.
istituto	ist.
izvestiya	izv.
jaarverslag	jaarv.
Jahrbuch	Jahrb.
Jahresbericht	Jahresber.
Jahresheft	Jahresh.
Jahresversammlung	Jahresvers.
Jahrgang	Jahrg.
January	Jan.
journal	jour.
Klasse	Kl.
kongelige, königlich, kungliga	kgl.
koninklijke	koninkl.
-kündig	-k.
laboratory	lab.
library	libr.
Lieferung	Lief.
literary, literature	lit.
livraison	livr.

locality	loc.
magazine	mag.
manuscript, -s	ms., mss.
March	Mar.
mathematic(al), mathematische	math.
mechanic(al)	mech.
meddelanden, meddelelser	medd.
mededeelingen	mededeel.
medical	med.
meeting(s)	mtg.
member	mbr.
memoir, memoria, mémoire	mem., mém.
memorandum	memo.
metallurgic(al)	metall.
meteoritical	meteorit.
meteorologic(al)	meteorol.
microscopic(al)	micros.
mijnbouwkundig	mijnb.
military	mil.
mimeographed	mimeo.
mineralogical	mineralog.
miscellaneous	misc.
Mitteilung(en)	Mitt.
Monatsbericht	Monatsber.
Monatsheft	Monatsh.
Monatsschrift	Monatsschr.
monograph	mon.
montanistisch	montan.
Mount	Mt.
mountain, mountains	mtn., mts.
musée, museo, museum	mus.
Nachrichten	Nachr.
nacional	nac.
national	natl.
natural	nat.
naturforschende	naturf.
naturhistorisch	naturh.
Naturwissenschaften	Naturw.
naturwissenschaftlich	naturw.
natuurkundig	natuurk.
nouveau, nouvelle	nouv.
November	Nov.
number, -s	no., nos.
nummer	nr.
oceanographic(al)	oceanog.
October	Oct.
ornithological	ornithol.
page(s)	p.
paläontologisch	paläont.
paleoecologic(al)	paleoecol.
paleogeographic(al)	paleogeog.
paleontologic(al)	paleont.
pamphlet	pamph.
Pan American	Pan Am.
part, -s	pt., pts.
petrographic(al)	petrog.
petrologic(al)	petrol.
philosophical	philos.
photogrammetric(al)	photogramm.
photograph, -s	photo., photos.
photographic(al)	photog.
physical, physikalisch	phys.
physiographic(al)	physiog.
planning	plan.
plate, -s	pl., pls.
polytechnic	polytech.
popular	pop.
praktisch	prakt.
preliminary	prelim.
proceedings	proc.
professional	prof.
progress	prog.
project	proj.
prospecting	prosp.
publication, -s	pub., pubs.
published	pub.
quadrangle	quad.
quarterly	quart.
rapport	rap.
reconnaissance	reconn.
record, -s	rec., recs.
recueil	rec.
rendiconti	rend.
report, -s	rept., repts.
reprint, reprinted	repr.
review(s), revista, revue	rev.
rivista	riv.
Saint, -e	St., Ste.
sällskapet	sällsk.
Sammlung(en)	Samml.
Schrift(en)	Schr.
schweizerisch	schweizer.
science(s), scientific	sci.
section, -s	sec., secs.
sedimentary	sed.
seismographic	seismog.
seismologic(al)	seismol.
selskab	selsk.

September	Sept.
series	ser.
session	sess.
Sitzungsbericht	Sitzungsber.
Skrift(er)	Skr.
sociedad, société, society	soc.
Soyuz Sovetskikh Sotsialisticheskikh Respublik	SSSR
special	spec.
speleological	speleol.
station	sta.
stratigraphic(al), stratigraphique	strat.
summary	summ.
supplement(s), supplementary	supp.
technic(al)	tech.
technologic(al)	technol.
Territory, Territories, Territorial	Terr.
tidskrift	tidskr.
tidsskrift	tidsskr.
tijdschrift	tijdschr.
tijdskrift	tijdskr.
topographic(al)	topog.
transactions	trans.
transportation	transp.
und	u.
Union of Soviet Socialist Republics	U. S. S. R.
United States	U. S.
university	univ.
vaterländisch	vaterl.
Verein	Ver.
Verhandelingen, Verhandlung(en)	Verh.
Versammlung(en)	Vers.
vetenskap	vetensk.
vetenskapsakademi	vetenskapsakad.
videnskab	vidensk.
videnskaberne	vidensk.
volcanologique	volcanol.
volume(s)	v.
wetenschappen	wetensch.
Wissenschaft(en)	Wiss.
Wochenschrift	Wochenschr.
Zeitschrift	Zeitschr.
Zentralblatt	Zentralbl.
zhurnal	zhur.
zoologic(al), zoologisch	zool.

TITLES OF REPRESENTATIVE SERIAL PUBLICATIONS AND THEIR ABBREVIATED FORMS

The list below includes the titles and abbreviated forms of many serial publications cited in Geological Survey reports.

Abhandlungen der Akademie der Wissenschaften in Göttingen, Mathematisch-physikalische Klasse—Akad. Wiss. Göttingen Abh., Math.-phys. Kl.

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ILLUSTRATIONS

The term "illustrations" is used in the Geological Survey in a very broad sense. It includes geologic maps and cross sections, topographic maps, mine maps, special maps of many kinds, diagrams, sketches, columnar sections, charts, graphs, and photographs. The information and suggestions presented in the following pages relate specifically to the illustrations in the book publications, to the series of maps, charts, and atlases, and to the geologic and other maps of the United States, the States, the Territories, and special areas. Like the other parts of this volume, this section on "Illustrations" does not discuss topographic maps, base maps, river survey maps, index maps, and status maps showing progress of work and aerial photography available.

Illustrations used in the Geological Survey are selected and planned with a view to their usefulness. They explain or present graphically the subject matter of the Survey's publications. The number and the kinds of illustrations that are used bear a close relation to the subject and purpose of the publication. If a manuscript report or map is preliminary or ephemeral, the illustrations should be simple and inexpensive. If the report or map represents either the sum of knowledge on a subject or extensive research on some particular area, the illustrations may be elaborate. The character of a manuscript report or map generally determines the form of its publication which, in turn, determines the size of the printed pages and the size of the figures and most of the plates.

All steps in the making of an illustration—the preparation of the original manuscript copy by the author, the final drafting, and the reproduction—are closely related; each is dependent upon the others for the best and most economical results. If the material is well handled in all three steps it will produce an excellent illustration at minimum cost, but if it is poorly handled at any step the effectiveness of the illustration may be reduced or lost and the cost will be greater. Because these three steps are related, and because the author is responsible for the first of the three, he can contribute much to the success of the joint effort. To that end, advance planning of many illustrations through conferences of the author, supervisor, and persons trained in the appropriate art is an important element.

DRAFTING AND REPRODUCTION PROCESSES

The drafting and reproduction processes used currently for different kinds of illustrations are briefly described here so that authors may

understand the discussion in later pages about the compilation and submission of original copy. This description covers the following broad groupings of illustrations: multicolored maps, simple black-and-white maps, black-and-white line drawings, and photographs.

MULTICOLORED MAPS

The principal multicolored maps, other than standard topographic quadrangle maps, issued by the Geological Survey are geologic maps. Multicolored maps and other illustrations showing features other than geologic features are issued occasionally, but the problems in preparing and printing them are similar to those involved in the publication of multicolored geologic maps. The work required to convert manuscript geologic maps to printed multicolored maps involves both cartographic and map-reproduction processes that are very closely related.

The printing plates are produced by photomechanical processes. From the plates the maps are printed on single- or multiple-color rotary offset presses. Each color applied to the map requires a separate printing plate. The most important problem in reproducing a highly detailed geologic map is the exact registration of all the colors and lines. Each color must fit its boundaries within visible limits; it must neither "pull away" from the boundaries nor overlap them.

The different kinds of copy that are used for making printing plates are prepared by drafting, scribing on plastic, engraving on glass, and hand transfer, which are described below.

Drafting.—The preparation of final copy by drafting for use in making printing plates is done on scale-stable cartographic mediums. A separate piece of copy is prepared for each color that is to appear on the final map.

When printing plates prepared from drafted copy are expected to fit a preexisting base, the following procedure must be used to obtain the most efficient and economical results: the author's compilation, as well as all stages in the final drafting and color separation, is done on dimensionally stable material. If such material is not used, some or all pieces of drafted copy "go out of scale" differentially, and extra time is consumed and expensive camera work is necessary to produce glass negatives that are in accurate register with each other and with the base.

At the time of writing (1957), the most stable material for drafting for final reproduction is a metal-mounted board. This type of board is a sheet of aluminum to which a high-quality drafting paper has been affixed by heat, pressure, and an adhesive. Other materials that are reasonably scale stable are glass cloth and some plastics.

The selection of the medium for the drafting of each piece of copy is determined by one or more factors, including the size of the copy, the complexity of the registration problems, and the convenience of the medium in making the necessary copies.

If glass cloth or plastic is used for all pieces of copy for one illustration, any slight change in dimensions will be the same in all pieces of copy. Under certain conditions, 2 or all of the 3 mediums (metal-mounted boards, glass cloth, and plastic) are used for the different pieces of copy for a single illustration.

Scribing on plastic and engraving on glass.—For some geologic maps the author's line work is photographed and printed on a sheet of emulsion-coated plastic that is termed "scribe-coated plastic"; the lines are then cut ("scribed") in the scribe-coat to a standard width with a stylus. The resulting sheets are used in the same manner as standard photographic negatives in the preparation of printing plates. Mechanical negatives for the various overprint colors and patterns to be used on the final map are sometimes produced on plastic or glass, one sheet for each color, by various etching and stripping processes.

Some very large geologic maps with complex patterns are engraved on glass to insure perfect registration of the final printing plates. The geologic maps of Oklahoma (1954) and Montana (1955) are examples of maps produced by engraving the geologic contacts and faults on glass.

Hand transfer.—Copy for some geologic color overprints is prepared by hand transfer. In this procedure the drafted, scribed, or engraved copy of the black-line geologic features is converted by several processes to a press plate in exact register with the press plates of the base. Next, combined prints showing the geology, base, and drainage are made for preparing the color guides for the geologic patterns; one sheet is needed for each color-printing plate. The areas of the geologic distinctions are then delineated by a hand gumming-out process on the press plates, and the patterns are hand transferred to the open areas on the plates.

The hand-transfer method is used whenever the drafted copy is distorted, requiring adjustments in shape to fit the map base. The preparation of printing plates for a geologic map by this method is time consuming. The cost of producing a map by this method far exceeds that of a map for which all pieces of copy are prepared by drafting and color separation on scale-stable materials.

SIMPLE BLACK-AND-WHITE MAPS

The preparation of black-and-white maps generally presents none of the complexities involved in the reproduction of multicolored maps.

For most maps the copy is photographed, and from the resulting negative a single offset-printing plate is made. Such maps need not be drafted on scale-stable materials.

BLACK-AND-WHITE LINE DRAWINGS

Small black-and-white line drawings for book publications may be reproduced by photolithography or photoengraving. In the latter process the press plates are prepared by etching the background so that the work to be printed is raised above the remainder of the plate.

PHOTOGRAPHS

Photographs of fossils, aerial photographs, and photographs of rocks and minerals for which the retention of fine detail is necessary are reproduced by a photogelatin (collotype) process. In this process the printing-plate image is photographically fixed on a gelatin surface.

Ordinary photographs are reproduced by photoengraving or photolithography, using a halftone screen.

PREPARATION OF AUTHOR'S COPY

QUALITY OF COPY

Author's copy for illustrations should be clean, clear, and accurate. It need not be a finished drawing suitable for reproduction, as it will be redrafted partly or completely. Efforts directed by an author toward the preparation of a finished drawing for use in official publications are wasteful. Illustrations should not be finally drafted until after the manuscript text and the author's copy for the illustrations have been approved for publication. Copy should be in ink but may be in pencil if the lines are sharp and strong enough to photograph for redrafting. Final drafting from poor or unintelligible copy is slow because much time must be spent in interpreting uncertain or obscure features, and personal conferences or correspondence with the author may be required. The manuscript copy of each illustration should be complete. The author should not expect the reviewers, the draftsman, or the map editor to supply missing data. In short, each original drawing should be so made that it can be readily understood and followed by the draftsman.

If a report includes many related illustrations, it is the author's responsibility to check all pieces of copy for consistency and to make certain that each illustration carries all necessary suggestions or directions for drafting, so that the draftsman will not have to refer to other illustrations or to the text. Among the necessary suggestions the author should state his opinion about the publication scale, which

should be confirmed or modified during the review process prior to final drafting.

Final drafting is generally at a scale 20 to 30 percent larger than publication size, and it is helpful for author's copy to be submitted at the larger scale. Author's copy at a scale two or three times publication scale not only is unnecessary—it is undesirable. In plotting complex geologic maps authors should be careful not to show detail that will not reproduce at the publication scale.

An author not familiar with the problems connected with the drafting of geologic maps and sections, isometric diagrams, and other complex illustrations should consult his supervisor or manuscript-processing unit. If required, base maps on scale-stable compilation materials should be ordered from the manuscript-processing units through the Washington office as soon as the mapping project has been approved.

ILLUSTRATIONS (EXCEPT PHOTOGRAPHS) IN BOOK PUBLICATIONS

The number of illustrations that may be used in the book publications of the Geological Survey is limited only by the needs of the subject matter. It should be pointed out, however, that multicolored maps generally may not be used in circulars.

In preparing illustrations for a book publication an author may be tempted to use more illustrations than are necessary. The number of diagrams, maps, or charts submitted is rarely in excess of the needs of the paper, but in many manuscripts an excessive number of photographs is submitted. Review of the manuscript report and its approval for publication will reflect administrative judgment that the illustrations selected are essential. Later, during the preparation for reproduction, it may be recommended that some illustrations be rejected because they are not acceptable for effective or economical reproduction.

The printed size of each text illustration affects its cost and determines its position in the text. If the illustration can be printed in one color (black on white) within the size limits of a page of type and if it is not a collotype, it requires no special handling, as it and the text are printed at the same time. If the illustration is too large to fit on a page, it must be folded and placed in a pocket at the back of the report or inserted between the pages of the text. Collotype illustrations are inserted between the text pages. The insertion of folded and page-size illustrations is an expensive hand operation.

The maximum space available on a printed page (text page) for illustrations, their titles, and any explanatory matter that is not included in the illustrations is given on page 127.

Dimensions, in inches, of type pages, trimmed pages, and text figures

[Height includes running heads]

Series	Type page		Books trim to—		Text figure with explanatory matter at—			
					Bottom of page		Side of page	
	Width	Height	Width	Height	Width	Height	Width	Height
Bulletins and water-supply papers	4⅜	7⅞	5⅞	9⅛	4⅜	6½	7	4
Professional papers	7⅛	9½	9⅛	11⅜	7	8½	9	6½
					[1] 3⅜	8½	9	[1] 3
Circulars	6½	9	8	10½	6½	8½	9	6
					[1] 3	8½	9	[1] 3

[1] Figure occupying 1 column.

The author should keep in mind the printed sizes of illustrations, and plan his rough draft so that, after final drafting and reduction, as many illustrations as possible can be printed as text figures. Trimming or sacrificing the limits of the area shown in order to reduce the illustration to text-figure size will often be balanced by the advantage gained in placing the illustration within the text. The author should consider the amount of detail required for his report and indicate the amount of reduction possible to illustrate the subject properly.

Many detailed maps to be most useful should be reproduced on available base maps. The scales for index maps and other small illustrations should be adjusted to fit the available space.

SERIES OF MAPS, CHARTS, AND ATLASES

The geologic quadrangle map series consists of multicolored maps published on standard topographic bases and accompanied by a short text. The outside limits of geologic maps in this series coincide with the topographic-map base. If glass negatives or engraved copper plates for the topographic bases are available in the Survey's map-reproduction plant, geologic quadrangle maps should be compiled by the author on an enlarged brown-line print of the base on scale-stable material. The existence of glass negatives or engraved copper plates for topographic bases in the map-reproduction plant means that the topographic map has been completed and released to the public. The same glass-plate negatives and engraved copper plates used in making the final topographic printing plates are used to make the enlarged brown-line print of the base that is furnished to authors. When this procedure is followed the printed geologic map will be in as perfect register as cartographic materials will permit, and the

geologist's work will be reproduced exactly as it was originally plotted. The author should never color the compilation copy on scale-stable material. When the compilation is completed a color guide can be made by various reproduction processes or by tracing the original and then hand coloring the geologic formations on the new copy.

If glass negatives for topographic bases are not on hand in the map-reproduction plant, or if for justifiable reasons the quadrangle is not compiled on a scale-stable material, final drafted copy for reproduction can be prepared by other means. Such maps, however, take a longer time to process, are less accurate, and entail high cartographic and production costs.

In submitting copy for the geologic quadrangle map series the maximum text, without figures, is 1,000 lines (900 lines are preferable) of typed manuscript. A line here is defined as 68 characters (letters, punctuation, and spaces) of elite type. If text figures are used the author should plan a shorter text to provide space for them; 1 square inch of a text figure and its title equals 2 lines of type.

Maps of the other geologic map series and also the charts and atlases are more flexible in design; they may be published as multicolored or black-and-white maps, on planimetric or topographic bases, and with or without texts. They may cover quadrangles or irregular-shaped areas and may be accompanied by cross sections, stratigraphic columns, and text-insert figures.

LARGE GEOLOGIC MAPS OF SEVERAL QUADRANGLES

If glass negatives or engraved copper plates for topographic quadrangle maps are available for the area to be mapped, the author should order brown-line prints of the base on metal mounts or other dimensionally stable material. The largest stable units practical to handle are 36 by 40 inches. Larger areas can be covered by two or more pieces. If neither glass negatives nor engraved copper plates for the topographic bases are available, compilation becomes a special problem and should be discussed with the supervisor and the branch manuscript-processing unit.

STATE GEOLOGIC MAPS

The compilation of State geologic maps is a long and complex procedure. It requires careful advance planning in which choice of compilation material, compilation and publication scales, degree of geologic detail, arrangement of map explanation, wording of statements on cooperation, scheduling, and related matters are agreed upon in group meetings of the compiler and responsible representatives of the branch, division, and map-reproduction units.

COMPILATION AND PUBLICATION SCALES

When geologic maps are compiled on enlarged copies of existing base maps and are to be published on such base maps, the following scales generally will be used:

Compilation copy	Base maps		
Scale	Scale	Miles to the inch (approximately)	Coverage (latitude and longitude)
1:400, 000	1:500, 000	8	
1:192, 000	1:250, 000	4	
1:96, 000	1:125, 000	2	30′
1:48, 000	1:62, 500	1	15′
1:24, 000	1:31, 680	½ (exactly)	7½′
1:20, 000	1:24, 000	⅝	7½′

PHOTOGRAPHS

Published photographs must be clearly related to the subject matter of the text. Also they must be related to the text by markings on each photograph or suitable reference in the title. In selecting photographs the author should consider their scientific value rather than their composition and pictorial value, but a feature worthy of illustration should not be represented by an inferior photograph. A photograph is not necessarily good for reproduction simply because it shows some particular feature; the quality of the print also should be considered. Some loss of detail in reproduction can be expected, and therefore only the clearest and the most effective prints obtainable should be submitted. The best prints for reproduction are those made from negatives of evenly illuminated subjects in which the details are sharp. A good print for reproduction is one that has maximum detail in the shadows and highlights and yet is not dull or "flat." An excessively contrasty print is as unsatisfactory for good reproduction as one that is too flat. Photographs of special or significant objects that are obscured by foliage or lost in haze do not make acceptable illustrations. Usefulness of the photograph may be increased by including some familiar object in the view to provide a size comparison.

Photographs submitted with manuscripts are deleted if the subject is commonplace, unnecessary, or otherwise inappropriate, or if the prints submitted are not of reproduction quality. It is the author's responsibility to furnish prints of good quality for reproduction; if he submits a poor print or one that is too small, it may be deleted.

A photograph that has only minor defects can be retouched; such photographs should be larger than publication size, as the effects of retouching will be softened by reduction. A photograph rarely can be satisfactorily enlarged in reproduction unless it is very sharp in detail, and it should not require retouching. If a print is of doubtful quality, two copies should be submitted, one glossy and the other having a matte surface, for use if the print must be retouched. Some photographs can be made to fit a page either by trimming ("cropping") them or by reducing them in the reproduction process. Where reduction results in loss of detail, trimming may be preferable, and the author should submit enlarged prints that can be either trimmed or reduced to the proper size.

If lines, letters, or other reference marks are required on the face of a photograph, they should be placed on a sheet of transparent paper pasted to one edge of the print. The marks should be placed on the overlay with great care, for indentations on a print will show when it is photographed. Ink should not be used to mark photographs, as it may penetrate the paper and deface the photograph. Staples and paper clips must not be used on photographs; they cause creases or holes that will show when the photograph is copied. Likewise, writing on the back of a photograph with a hard pencil may crack the glossy front surface.

In making up a plate composed of many figures—photographs of fossils, rocks, and minerals—the author should try to group related figures together and to achieve at the same time pleasing balance and composition. If they cannot be kept together the larger figures should be placed in the lower part of the plate and the smaller ones above. In a plate consisting of one large view and several smaller ones, however, the large one should be placed slightly below the center of the plate and the smaller figures arranged in the remaining space. In assembling copy for collotype plates the space should be filled completely to the margins of the usable space on the page, without excessive space between figures. A designating number should be placed on the margin at the lower right corner of the photograph, and the series should begin with 1 at the upper left corner of the plate and continue in numerical order to the right across each succeeding row from top to bottom of the plate.

Photographs showing different views of the same specimen, or several specimens of one species, should be placed on the same plate. Several views of a single specimen may be given the same number with a, b, c, and so on. If there are too many for one plate they should be put on consecutive plates. In a large paper the usability of the report is increased if the photographs are arranged on the plates in the same order in which the fossils are described in the text. This arrangement

brings like forms together and facilitates comparison. The author's name and a condensed title of the report should be placed on the plate, preferably on a cover sheet pasted along the top edge of the mounting board. All descriptive matter, such as name, author, view, magnification, museum number, and text reference, should be placed in the long list of illustrations.

Except for mounted plates of fossils and similar material, it is preferable to submit unmounted photographic prints for use as illustrations.

Copyrighted photographs or other illustrations may not be used without the consent of, and credit to, the owner of the copyright. The author should obtain the written consent of the owner for the use of such illustrations and submit with the illustrations the letter or other appropriate evidence of the consent.

Photomicrographs.—The correct name for pictures taken through magnifying devices is "photomicrograph," not "microphotograph." It is essential to show accurately the size of features in such pictures as they finally appear on the printed page. This is done by placing a bar scale in an appropriate place on the photograph.

Paired photomicrographs of thin sections under both parallel light and crossed polarizers should always be placed together on the same plate, either side by side or one above the other. This same arrangement should be used for pairs of photomicrographs of polished sections.

Photolibrary.—The Survey's photolibrary at present (1957) is in Denver, Colo. Authors should deposit their photographs and negatives there at the completion of each official project. This collection of pictures is available for consultation by Survey authors who may find photographs by others appropriate to their needs. Also it may be consulted by non-Survey persons, for whom prints may be made at their expense.

TRANSMITTAL OF COPY

The author should assemble all illustrations and should number them consecutively, as figures. His numbering should be in the order of the principal reference to, or discussion of, the illustration in the text. The numbers and order should not be changed even if, as is likely, he rearranges the text in the course of review. For book publications the illustrations will be separated into plates and figures by the illustrators and editors, but in paleontologic reports they will be so separated by the author before he transmits his manuscript report. The number of the illustration should appear in a prominent place on the drawing, not on a separate slip attached to it, and if the drawing is in several parts each part should be clearly indicated. If illustrations are added after the first numbering, they may be designated by a fractional number or a letter (fig. 12.1 or fig. 12a). The new titles

should be inserted in the list of illustrations and at the proper places in the text. If an illustration is eliminated, its crossed-out number should remain in the list. If an illustration is shifted from its original place, the appropriate change in the manuscript-page number in the list of illustrations is all that is necessary to serve as a guide in the final numbering.

The author should not omit numbers in the text references to illustrations because of the possibility that the numbers may be changed in the final numbering. The editor who inserts the final numbers must know which illustration is being cited; if the number is left blank he may have to guess, and his guess may be wrong. It makes no difference, for example, whether an author's original illustration is numbered 7 or 700 if the editor knows that this particular illustration is to receive the final number 6. When the author makes changes he should be certain that these changes are made on the illustration, in all lists, and in the text.

Illustrations should not be inserted in the text but should be kept in a separate envelope or package, and all should be submitted with the text. In large reports, to aid in reviewing and preparing the illustrations for drafting, the figures should be placed in manila folders, and each figure should be accompanied by any directions or suggestions the author may wish to make concerning it. The folders should be kept flat, and the whole group should be protected by substantial covers. Larger maps on paper should be rolled and placed in tubes. To avoid the danger of loss, notes and titles should not be loosely clipped to copy but should be fastened securely to it.

Occasionally an author, in a mistaken desire to be helpful, submits pieces of material that are not directly a part of the final illustration but that were used in its compilation. The final copy submitted with the report should consist only of the material required for the final drafting.

For transmittal for administrative review, the text should be accompanied by copies—not original drawings—of illustrative material; but, of course, the hand-colored copies and all other copies should be complete and clearly legible to facilitate their examination. Metal-mounted boards, drawings on glass cloth and plastic, and similar original material (including negatives from which copies have been made) should be retained by the authors, the supervisors, or the manuscript-processing units and not sent forward until the manuscript is ready for transmittal to the editors and illustrators.

EXAMINATION OF FINAL DRAWINGS

All illustrations, after final drafting, are examined critically by qualified persons for accuracy of statement, correct spelling, proper treat-

ment of topographic and geologic features, and accepted Survey usage. After they have received this review they are submitted for examination by the author or a representative of his supervisor. This is not the time to redraw the illustrations but only to find any errors that may have been made in preparing the final drawing from original copy. The illustrations should receive the closest scrutiny at this time to avoid subsequent extensive and expensive changes in the proof stage. Finished drawings, when returned to the author for final checking, are accompanied by the author's original copy, with which they should be carefully and thoroughly compared. The author should mark lightly all necessary corrections on the finished drawings with a light-blue nonphotographic pencil. His approval of the finished copy, subject to such corrections and additions as may be required, should be indicated by initialing each drawing in the box stamped on the copy or by initialing the attached check sheet. He should verify all type matter and other lettering and assure himself that no mistakes have been made in grouping the photographs on the plates, especially those that have been regrouped since they left his hands.

CORRECTING PROOFS OF ILLUSTRATIONS

For many types of maps, proofs in color are provided very economically by the photocolor process. This method is used whenever possible; but for some maps, because of size limitations and other considerations, a lithopress proof may be furnished.

The author should examine the proofs of his illustrations closely and should compare them carefully with the original drawings. A cursory inspection may fail to detect errors that have not been caught by the regular proofreader. Every correction should be clearly marked in the body of the proof and enclosed in a loop, from which a line should be carried to a marginal note or comment. The ordinary proofreader's marks should be used in correcting type matter or lettering, such as that in a geologic map explanation. The author or another person examining the proofs should initial each one in the box stamped in the lower right corner or on the attached check sheet.

Proofs should be held only long enough to examine them properly and to compare them with the original illustrations. If the author holds proofs beyond a reasonable time he may delay the publication of the report.

Proofs of halftones (photoengravings), collotype plates, and other black-and-white illustrations may not be submitted to the author, because the proof is an exact photographic duplicate (except for size) of the prepared illustration already approved by the author.

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In examining proof an author should note the following:

1. Changes cannot be made in photoengravings except by eliminating parts or by cutting away defects and connecting lines. If additions are required, reengraving is necessary.
2. A slight loss of detail should be expected in all halftones, especially in those that are smaller than the copy submitted. If the proof shows a general loss of detail the fault usually can be found in the copy.
3. Minor changes can be made in black-and-white and color photolithographs. It is customary to approve all photolithographic proofs subject to the corrections indicated. If the changes are numerous, however, second proofs may be required.

TERMINAL SECTION

Many reports have a relatively short terminal section which contains concise statements about each principal point of the subject matter. In a short report the section does not necessarily have to have a separate heading; it may be simply the last paragraph in the text. The nature of the terminal section varies with the subject matter of each report, as may be inferred from the following headings used in different published reports: "Discussion of results," "Conclusions," "Application to field problems," and "Recommendations for further study."

INDEX

The index of a book report is of inestimable value to the reader if it is well prepared; otherwise it can be a source of irritation and frustration. All but the shortest reports, or those which by their subject matter and arrangement do not require one, need indexes. The index is not a part of the manuscript but is prepared by the editor from the page proof. The author, however, may be asked by the editor to assist by underlining, in galley or page proof, words that he thinks should be indexed, or he may submit with his manuscript a list of terms that should not be missed when the index is prepared.

SUGGESTIONS AS TO EXPRESSION

COMPOSITION

A scientific report is a special type of exposition; it presents facts and conclusions that give the report its value. Its essential qualities are accuracy both of fact and presentation, clearness so that the reader cannot misunderstand or misinterpret, and conciseness and simplicity so that the substance of the report will be easy to grasp. Conciseness does not mean the elimination of essentials but the elimination of padding and purposeless repetition.

Other qualities of good exposition are unity, coherence, and emphasis. Unity implies oneness and completeness in thought and in expression; coherence deals with arrangement of material; emphasis deals with effectiveness of presentation.

Unity, in the report as a whole, requires that the subject stated in the title or a thesis sentence be adhered to strictly and that every division, paragraph, and sentence be aimed at developing that subject. Unity in the paragraph demands that there be but one central thought and that every sentence contribute to the development of that thought. An essential aid in obtaining unity is provided by the topic sentence, which states the subject of the paragraph. The topic sentence, usually the first one in the paragraph, notifies the reader when a new thought is being introduced; it thus commands the attention and sustains the interest of the reader. A topic sentence may not be needed when the thought of the paragraph is easily grasped, but it is generally helpful to include one. Variety that is consistent with unity within the paragraph is desirable, and monotony in the structure and length of the sentences should be avoided.

Coherence requires that the parts of the report be arranged logically and that they be tied together in a way that will show their exact relation. Not only should words, phrases, and clauses be arranged in sentences in an order that will easily lead the reader forward, but the sentences themselves should be properly grouped in paragraphs, and the paragraphs should be presented in logical sequence under suitable topic headings. Coherence between parts can be attained by ending a part with a word, phrase, or sentence that points both forward and backward, or by a simple statement of the subject in the first sentence of the new part.

Coherence between paragraphs is attained by means of transitional words or phrases. If a discussion is long, a brief transitional paragraph may be needed. The relation between sentences can be shown by inserting a transitional word or phrase or a reference word, by repetition of a significant word or phrase used in the preceding sentence, by repetition of a statement, or by putting at the beginning of a sentence the part that ties the thought most closely to the preceding sentence.

The beginning and the end of the paragraph are positions of special emphasis, but if the paragraph is written effectively special emphasis may not be needed in any part of it. Paragraphs should not be so long that the thought is hard to follow. Nor should they be so short and choppy that they lose not only emphasis but also unity and coherence.

THE SENTENCE

The subjects discussed in the following pages include some, but not all, of the useful subjects on unity, coherence, and emphasis in the

sentence; those discussed deal especially with matters of interest to Survey authors.

UNITY

Unity in the sentence demands that there be but one thought. The sentence may be simple, compound, or complex; but every word, phrase, and clause should help to develop that one thought.

COMPLETENESS

Each sentence should be complete, both in thought and in construction. The reader should not have to guess at the author's meaning or have his thought distracted by the omission of words. Note the improper or undesirable omission of words in the sentences given below.

Article

I consulted the secretary and [the][4] president of the mining company.
The drilling rig and [the] pipe carrier were destroyed.
Access to the ore was provided by a drift and [a] winze.

Connective "that"

These sediments show [that] the Black Point basalt is as old as the Waimanalo stand of the sea.
He believed [that] the terrace was elevated again.
The analyses indicate [that] the water has a high concentration of dissolved solids.

Infinitive or sign of infinitive

The outcrop is reported [to be] traceable for 70 feet.
The writers intend to delineate the areas that are anomalously radioactive and [to] present chemical analyses.

Possessive

My packer and [my] field assistant accompanied the mapping party.

Preposition

Chalcopyrite is found on the surface and [in] the fissures.

Pronoun

The work has been carried on under the general supervision of John Smith, [who was] assisted by William Jones.
Local inhabitants spoke of large masses of silver ore which were exposed at the surface, and [which] were exploited for years.

Verb or part of verb

This program is important and [is] appreciated by those affected.
The work was [done] for the State Survey.
These surveys were [made] for economic reasons.

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[4] Corrections in the examples of sentences and phrases given in this volume are indicated by italicizing the words that should be omitted and placing in brackets the words that should be added.

The copper produced in Montana is [derived] almost entirely from the mines at Butte. (See also "To be," p. 169.)

The region was uplifted, and the streams [were] rejuvenated.

Comparisons

The schist is much closer to the settlement than [to] the river.

The average annual precipitation in the area is less than [that in] other parts of Wyoming.

The purpose and scope of this report are different from [those of] most previous reports.

Uranium is commercially more important than any [other] element produced in the area.

Miscellaneous omissions

Exposures of the rock are confined to comparatively small areas on Racetrack Creek near [the point] where that stream leaves the quadrangle.

These rocks contain a few rusty-weathering beds [whose color is] due to the abundant pyrite they contain.

The following are analyses [of representative samples] from mines in the eastern part of the region.

The concentration depends directly upon the chemical composition of the ore and the [position of the] water table.

COORDINATION AND SUBORDINATION

The long sentence is not objectionable if it is well knit together and reads smoothly. The long, rambling sentence consisting of a series of clauses connected by "and" or "and so" or containing long parenthetic clauses interrupts the continuity of thought. Correct it by breaking it into shorter sentences or by making some of the clauses subordinate. A choppy sequence of short sentences is also undesirable, for it is hard to read. Generally such sentences can be combined in a way that will make the relation of their thoughts clear. Principal and subordinate clauses should not be treated as though they were of equal weight. The principal clause should contain the main thought, and the other clauses should be subordinate to it. Make the relative value of clauses evident by using the right connective—a coordinating connective to join clauses of equal rank and a subordinating connective to join clauses of unequal rank. Furthermore, use the transitional word or phrase that shows the exact relation in thought.

COHERENCE

Arrange words, phrases, and clauses in logical order, so that the sentence will convey at once, clearly and forcefully, the ideas to be expressed.

REFERENCE OF PRONOUNS

In many sentences, pronouns that require antecedents have none; in other sentences the grammatical antecedents are not the true ones—

The basins receive much of the runoff of the adjacent mountainous catchment areas, in which many streams rise, but *which* [the streams] end when they reach

the margin of the desert. (Grammatically both the first and the second "which" refer to "areas," but the second one was intended to refer to "streams.")

A *9-span* steel highway bridge [of 9 spans], 3 of which are over the normal river channel * * *. (The grammatical antecedent of "which" is "bridge"; the real antecedent is "9 spans.")

With it is much spotted ore that could be concentrated, but *that* [concentration] has not yet been undertaken. (The "that" in the last clause has no expressed antecedent.)

They enable stock to spread out *into territory* immediately after a rain [into territory] that they are unable to graze in normal times.

The lower salt series, which was deposited upon the Delaware Mountain formation in the Delaware Basin and which *it* filled [the basin] to overflowing * * *. (The second "which" does not refer to "lower salt series" but to "Delaware Basin.")

A succession of relative pronouns, each referring to a different antecedent (a sort of echelon arrangement), makes an awkward sentence. The following example shows how 1 "which" instead of 3 could have been used:

Among the steeper dips north of the synclinal axis are those *which occur* along the southeast flank of the Hamilton dome, which, like the Bell Rock dome, is situated upon the axis of an anticline *which* [that] almost parallels the Round Bottom syncline.

A word that refers back to an antecedent should not itself be made to serve as an antecedent for another word that follows. The weak construction that results is shown in the following example:

These men had been appointed commissioners by the King, to settle all controversies in the colonies. The matter was referred to them, *who* [and] after a full hearing [they] determined * * *. ("Them" is not an adequate antecedent for "who.")

Other troubles with antecedents are indicated below.

During early Tertiary time an area beneath the present mountains was arched, possibly by a deep-seated intrusion. This dome * * *. (No dome has been mentioned; change "This dome" to "The dome thus formed.")

Dry Creek and Cottonwood Creek contain many pools of alkaline water[,] which *are* [is] unfit for drinking. (The writer thought his "which" had to refer to "pools," but it was the water, not the pools, that was unfit for drinking.)

The basal beds rest unconformably upon *those of* the Fort Union formation. (The antecedent of "those" is "basal beds," not just "beds.")

The variation in the thickness of the shale seems to be due to erosion, for the sandstone rests on *it* [the shale] with irregular contact. (The real antecedent of "it" is not "variation" but "the shale.")

Only one bear was seen, and *their* signs [of bear] were not at all common. ("One bear" is not a sufficient antecedent for "their"—in fact, even a dozen bears that were seen would not be a sufficient antecedent; it was the signs of the unseen bears that were not common.)

Special care should be taken in the use of "it." Carelessness produces an obscure sentence.

If a public well [in a town] should enter an open passage in limestone into which a drainage well carries sewage, typhoid fever may be communicated to hundreds of *its citizens* [the people who use the water], even though the town may be miles from the source of contamination. (The antecedent of "its" is "a public well.")

In the following sentence "it" is used four times—twice impersonally and twice referring to the same thing:

It has not been possible to identify it with any of the described forms, and it seems to be so distinct that it is probable that additional examples could be recognized without difficulty. (The awkwardness could be avoided by writing, "It could not be identified with any of the described forms, but it seems to be so distinct that additional specimens probably could be recognized without difficulty.")

"This" or "these" should not be used alone where there can be any doubt as to the meaning, where the reader will be compelled to look back to find the antecedent, or where no antecedent has been expressed. The missing noun generally can be supplied, with advantage to the reader. Use of "which," "this," or "that" to refer to a whole preceding statement is appropriate occasionally where there is no doubt as to the scope of the reference. Often, however, there is room for doubt, and the general reference should be avoided. Insert a noun, such as "this fact," "a procedure which."

The rocks contain * * * numerous cavities. In these [cavities] minerals have been deposited. (Not "these minerals.")

In the Milesburg Gap the quartzite has been quarried to a considerable extent for ganister, and near *this* [the quartzite] quarry barite is found in narrow fissures.

ORDER

Related words and phrases should be kept together. Some writers misplace adverbs and adverbial phrases, especially the adverbs "only," "principally," "mainly," "chiefly," "alone," "also," and "too." Note the following sentences:

Their presence can *only* be determined [only] by tests.
The sediments were [derived] principally *derived* from quartzite.

In the following statement it is not clear which part of the sentence "when the time came" modifies:

I told him when the time came I would do it. (Write, "When the time came, I told him I would do it," or "I told him I would do it when the time came," according to the meaning intended.)

In the sentence "They suspended operations as the weather became colder and moved south," the statement says that the weather moved south. Write, "As the weather became colder, they suspended operations and moved south."

Prepositional phrases also become misplaced, as shown in the following examples:

Under such conditions it is easy to see that [under such conditions] the commercial development of these deposits * * *.

In Indiana recent writers have classified the rocks [in Indiana] as Utica or Eden.

On level 2 it is reported that considerable realgar and orpiment were found [on level 2].

Fossils [from Indiana] were described *from Indiana.*

From the ice water overloaded with glacial debris discharged westward [from the ice]. (Inserting a comma after "ice" is not a good remedy for poor construction.)

Occasionally an adjectival expression is misplaced, or is misused for an adverb, as well as being misplaced.

A *careful* sample of this rock was [carefully] taken for chemical analysis.

The granite was intruded during the *great* period of [great] structural deformation.

Leaves [little] room for *little* doubt.

The *luxuriant* gray green of the [luxuriant] sagebrush.

Tilted edges of [tilted] sandstone strata.

The *most prevalent* region of [most prevalent] cloudbursts.

A coarsely porphyritic [dark] rock of *dark* granular texture. (It is the rock, not the texture, that is dark.)

Two altered thin vitreous tuff beds. (Change to read "two thin beds of altered vitreous tuff.")

The sentence "There is a band of coarsely crystalline limestone carrying bunches of garnet-pyrite rock from place to place" presents the ludicrous picture of an animated limestone carrying bunches of rock hither and yon. Better write, "Here and there, in a layer of coarsely crystalline limestone, are bunches of garnet-pyrite rock." Also note that "layer" replaces "band," which refers simply to the visible edge of a layer.

The statement that "Care should be taken to see whether such wells are contaminated by frequent analysis" seems to slander the analyst. Write, "The water should be analyzed frequently to see whether such wells are contaminated," or "Frequent analysis of the water would show whether such wells are contaminated."

In general a phrase that applies equally to two or more items should be given with the first and not with the last.

Mountainous in the western part [of the quadrangle] and level in the eastern part *of the quadrangle.*

The thickness ranges from 700 feet at the east side [of the area] to perhaps 1,600 feet at the west side *of the area.*

The upper coal bed is as thick [as the lower], if not thicker *than the lower.* ("Is as thick as, if not thicker than, the lower" is correct but not nearly so euphonious.)

The split infinitive, in which "to" is separated by an adverb or other word from the verb to which it relates, preferably should be avoided. However, the split infinitive is sometimes justified, and to maintain a flat prohibition against it is unduly pedantic. (See also p. 144.)

PARALLEL CONSTRUCTION

The same construction should be used for elements that are parallel or coordinate in meaning. The following sentences illustrate the clumsy or misleading combinations that result from failure to observe this rule:

The average growing season *according to the Ennis record* is 98 days [at Ennis] and longer at the other stations.

The district has a moderate climate, in winter not very cold and *not excessively hot* in summer [not excessively hot].

The veins pinch out in one direction and *in the other* pass under the glacier [in the other].

These leaves range in length from 6 to 9.5 centimeters and [in width] from 4 to 7.5 centimeters *in width.*

The boundary between the belts is fairly distinct in [some] places and *in places* indefinite [in others].

The biotite replaced albite and quartz extensively and *sparingly replaced* hornblende [sparingly].

Most of the white arsenic is exported to America and *South Africa takes* most of the other products [to South Africa].

Limestone in massive beds and *thin beds of* shaly sandstone [in thin beds] * * *.

Estimating the potential value of power sites and [the] storage *capacities* [capacity] of reservoir sites * * *. ("Storage capacity" is an abstract term like "potential value.")

The replacement of pyrite by chalcocite would result in an increase in volume; the replacement of chalcocite by pyrite would *occur with a slight volume decrease* [result in a slight decrease in volume]. (Change in form of a phrase or clause may be taken by some readers to indicate a difference in idea, but in this example the only difference is that between "increase" and "slight decrease." The two clauses are parallel and should be expressed in the same form.)

The layers of shale are much thinner than the *chert* layers [of chert].

Correlatives (conjunctions used in pairs) should be followed by elements parallel in form. If a verb follows one, a verb should follow the other; if a prepositional phrase follows one, a prepositional phrase should follow the other. Note the following sentences:

Mr. Small *both* talked [both] longer and more rapidly than I had expected.

To the northeast, the sandstone bed *both* became [both] thicker and coarser grained.

Either the water was [either] too turbulent or too shallow for such bottom-dwelling species.

Either you will [either] report on time or be penalized for your absence.

This Nation *not only* has achieved great things [not only] in science but also in the arts.

The program *not only* aimed at development of techniques that [not only] would be useful in the present emergency but also would improve the efficiency of normal operations.

PARTICIPLES

A participle is an adjective formed from a verb. In character it resembles both an adjective and a verb. It has a present and a past form. Like other adjectives, participles modify nouns and pronouns, as in the following:

The falling rock interrupted the work.
The fallen rock obscured the opening.
Assisted by the Government, they built a new plant.

Participles resemble verbs in having objects and adverbial modifiers, as in the following:

Having completed his survey, the engineer made recommendations.
Using a new type of drill, they made rapid progress.
Discovering a new vein, the company reopened the mine.
Working rapidly, they saved the dam.

The participle affirms a state or action about something named by a substantive (noun, or a word or words used as a noun). Except in the "absolute construction" (see p. 143), the noun or pronoun modified by a participle can be included in the sentence as the subject of the clause to which the participial expression was attached. A sentence containing a dangling or misattached participle can be corrected by inserting the word that the participle modifies or by changing the construction of the sentence, as in the following:

Where the till is thick it is lighter in color, indicating less perfect oxidation. (The color indicates, not the till. Write, "Where the till is thick, its lighter color indicates a lesser degree of oxidation.")

The slopes are covered with debris, *thereby effectively concealing* [which effectively conceals] the coal beds. (The debris, not the slopes, conceals.)

Recognized as a bureau of information, *the services of* [it has to employ] two men *are required* to answer questions relating to topography alone.

Looking closer, chattermarks were seen. (Write, "Closer inspection showed chattermarks.")

Examined carefully [On careful examination] no fossils were observed.

Approaching the vein [As the vein is approached] through the tunnel, the serpentine is seen to be decayed.

Judging from the dips in the tuff [indicate that] a small hill has been mantled at this place.

Going seaward the boulders become smaller.

The feldspar crystals are normally light gray, thus giving the rock a spotted appearance. (Write, "The light-gray feldspar crystals give the rock a spotted appearance.")

The middle and western parts of the ore body *have a* [are] roughly tabular *shape* [and] dip*ping* southeast.

None of the old mine openings are accessible, but *judging from* [the] material on the dumps, [indicates that] the ore was massive, granular magnetite.

In each of the following examples the participial phrase is misused; it simply makes an additional statement that has no logical relation to the clause to which it is added:

Pine Bluff is the natural business center of the southeast half of the State, the average temperature being 62°.

It is thin and slabby, weathering to a cinnamon color.

The sandstones are more or less massive, occurring chiefly in the lower half of the formation.

The discharge of the spring is about 8 gallons a minute, its temperature being 90°.

Much of it is perfectly transparent, the oval grains being a quarter of an inch in diameter.

Douglas-fir grows between altitudes of 6,500 and 8,000 feet, the individuals averaging 16 to 18 inches in diameter.

The palate is long and narrow, *the roof of the same being* [and its roof is] strongly arched.

Lakes are plentiful [and range widely in altitude], occupying basins 100 to 2,000 feet above sea level.

In many sentences a participle can be replaced by a defining relative clause to gain emphasis and perhaps clarity.

A gravel-floored plain *sloping* [that slopes] gently toward the southeast * * *.

All thick coal beds *cropping out* [that crop out] in this field * * *.

Improvements involving participles are indicated in the sentences below.

They are therefore regarded as *being* of the same geologic age.

The basal formation of the group here *occurs resting* [rests] upon the Tejon formation.

These dikes *were found cutting* [cut both] the granitic rocks and *were noted cutting* the aplite dikes.

Remnants of quartzite *occur perched* [lie] along the crest of the ridge.

The cliff *rises facing* [faces] the river.

In the "absolute construction" the substantive to which the participle relates is included in the participial phrase, which expresses a condition or action that has some bearing on the main statement of the sentence. This construction is rare, and the more direct phrasing suggested in brackets in the following example seems preferable:

The difficulties being [As the difficulties are] by no means insuperable, a satisfactory interpretation may be worked out.

EMPHASIS

Emphasis of certain parts of a sentence is sometimes needed to express a thought effectively. Some of the common means used for obtaining it are given below.

POSITION

Important ideas should be given important positions—positions that command attention—and unimportant ideas should be subordi-

nated. The most emphatic positions in the sentence are the beginning and the end, especially the end. The reader naturally stresses the words immediately preceding and following punctuation marks. The objection to ending a sentence with a preposition is that an unimportant or weak word is placed in a position of emphasis. However, a sentence ended with a preposition may be better than an unnatural or awkward sentence written in an effort to avoid such an ending.

ORDER

Deviation from the usual order attracts attention, and in some sentences, as illustrated below, emphasis can be changed by transposing a word or phrase.

Gold mining has been the leading industry of the region for many years.
For many years gold mining has been the leading industry of the region.
The leading industry of the region has long been gold mining.
In this region gold mining has long been the leading industry.

VOICE

The passive voice is generally less emphatic than the active and should be avoided where emphasis is desired. "The fault strikes obliquely across the outcrop belt of the sandstone" is stronger than "The outcrop belt of the sandstone is crossed obliquely by the fault."

SPECIFIC TERMS

Specific and concrete terms are more emphatic than general and abstract terms. (See "Abstract terms," p. 183–185.)

MONOTONY

Monotony of sentence structure tends to reduce the effectiveness of a report. Variety in the length or form of sentences can be introduced by using both simple and complex or compound sentences, by changing the word order, by using meaningful connectives, and by avoiding too frequent use of participial phrases.

SPLIT INFINITIVE

Splitting an infinitive may misplace emphasis, as in "The ability to *accurately* record these data [accurately]." (See p. 141.)

MISCELLANEOUS PROBLEMS WITHIN THE SENTENCE

FORGETFULNESS OF SUBJECT

Some writers seem to forget their subject before they finish the sentence, as the following examples will show:

The flow of the spring is large[,] and [the water] is reported to be excellent for drinking.

The *average* thickness of the shale partings *is* [averages] about 1 millimeter but is extremely variable.

Although the rock has been greatly altered by [superficial] weathering, *the decomposition is believed to be rather superficial and* [but it] is regarded as affording entirely adequate foundations.

The *length of the* shell is only about one-fourth or one-fifth longer than it is high.

The principal granite-quarrying district of this group of States is at Salida, Chaffee County, Colo., and [the granite] is sold for monumental stone.

UNDESIRABLE CHANGE OF SUBJECT AND VOICE

Sometimes authors lose sight of the logical subject of a sentence. They begin a sentence with a clause containing an active verb and then ineptly introduce a new subject that leads to the use of a passive verb.

These vugs carry no gold and [do not affect] the tenor of the vein *has not been affected by them.*

The workings were closed and *examination of them* could not be *made* [examined].

The rocks show both bedding and cleavage, but *the amount of* [not much] metamorphism *has not gone far.*

This series is made up largely of shale *though* [but includes] much sandstone and limestone *are included.*

Occasionally a writer changes the subject simply because he does not stop when he gets through, as in the following examples:

It contains coal plants and the remains of bivalve crustaceans *are found in it.*

In June the company took over the Primrose claim and in July the Bluebell claim *was acquired.*

The break in the continuity of some sentences not only puts unemphatic words in the place of emphatic ones but detaches the final clause from the sentence, as in the following examples:

The deposits are composed of well-stratified rocks but [contain numerous] large irregular boulders *are numerous.*

The district has been intensely glaciated and [thus shows] two distinct types of topography *exist.*

The ore in this locality is of rather low grade, and very little mining [of it] has been attempted.

The coal-bearing beds are not overlain by glacial gravel, *so deeper weathering has taken place* [and therefore have been more deeply weathered].

In many sentences the passive form is wordy and weak, and it may mean that the author is trying to convince himself. "It was expected to be found" is distinctly inferior to "I expected to find it" or "The writer expected to find it." "It is believed by many geologists" is no better than the briefer statement "Many geologists believe." Phrases like "It is believed to be" and "It is supposed to be" are generally used only to express the writer's belief or supposition and serve merely to multiply words. The words italicized in the following sentences can easily be spared: "It is *believed to be* probably a stream deposit";

"It *is supposed that it* may be due to a fault." The reader will readily accept "may be," "probably," "perhaps," and the like as expressing the writer's judgment.

IMPERSONAL CONSTRUCTION

Beginning sentences with the impersonal constructions "There is," "There are," and "It is" not only may multiply words but also may have the effect of putting in an inferior place a subject that preferably should stand at or near the beginning of the sentence. Some sentences of this kind are listed below.

There are many other primary minerals contain*ing* phosphorus.

There are [At] some places *where* lignite beds are exposed.

There has been some [of the faults are later than] *faulting subsequent to* the deposition of the ore.

It is believed that these vugs probably represent openings *which were* formed by recent faulting.

It is the belief of the miners [believe] that the ground now being worked may be a slide.

There is a probability that [The gold content of] some of the veins may have [been] *had their gold content* increased by enrichment.

There is [The ash contains] no quartz *in the ash* and *it* is probably andesitic *in composition.*

There is [The outcrops afford] little direct evidence *from outcrops* of the faulting.

There is also a difference in the slope of the valley floors. (Write, "The valley floors differ also in slope," for the context showed that "slope" was the term to be emphasized.)

An initial "There is" or "There are" may undesirably detach a sentence from one that precedes it, as in the following example:

The Niagara is mainly a light-gray to light-buff fine- to medium-grained dolomite. *There are* [It contains] both thick and thin beds, and at certain horizons *there is* considerable chert.

Such phrases as "There are," "There were," "There have been," "It is," "It was" may, of course, properly and preferably begin many sentences, but the writer who is about to use one of these phrases should consider whether he cannot express his thought more forcefully in some other way. Examples of good usage are—

There is nothing more to be said.

It is raining.

It is impossible to set forth rules that will anticipate all contingencies.

There are three towns in the area. (The example is better than "Three towns are in the area.")

WRONG SUBJECT

Writers who use up their verbs in their subjects can sometimes find no other suitable verbs and must resort to weak, clumsy, or inappro-

priate substitutes, such as "occurred," "accomplished," or "transpired." A writer should consider whether an abstract or a concrete term will form the best subject of the sentence he is writing, and also which one will permit the choice of a suitable verb. The following sentences, as modified, illustrate the advantage of using concrete instead of abstract terms:

The *drainage of the* area is *accomplished* [drained] by three streams.

The principal production [Most of the ore produced] was mined from the Nevada property.

The *exploration of the* region was *carried out* [explored] by Smith.

During this epoch *aggradation of* the lowlands may have *transpired* [been aggraded].

Thus *a sudden inundation of* the desert would be *accomplished* [suddenly inundated].

The *movement of the* ore solutions here must have *been* [moved] very slow[ly] or [have remained] practically stagnant.

The *formation of the* ore deposits *occurred* [were formed] just after the igneous intrusions.

Confirmation of these reports cannot be *obtained* [confirmed].

The selection, equipment, and maintenance of stream-gaging stations are *performed* [selected, equipped, and maintained] according to long-standing methods.

Barite and [intensely silicified rock] *intense silicification usually always* accompany the ore [almost everywhere]. (In this sentence the compound subject links together a mineral and a process. Actually, the products of that process accompany the ore. Change "intense silicification" to "intensely silicified rock." Also, to avoid possible misunderstanding of "always," which is a term of time rather than of place, write "accompany the ore almost everywhere.")

PHRASES WRONGLY CARRIED ALONG

A phrase that qualifies the subject or its first predicate applies until a new subject is introduced, but in many sentences such a phrase is "carried along" to a part of the sentence to which it does not apply.

For full development the tree seems to require considerable water [for full development] and probably deserves its reputation as an indicator of ground water. (The phrase "for full development" does not apply to the second statement.)

The individual grains in the coarser limestone are as much as a millimeter in diameter and average 0.02 millimeter in the finer grained beds. (As written, the subject of the verb "average" is "grains." Write, "The individual grains in the coarser limestone are as much as a millimeter in diameter, and those in the finer grained beds average 0.02 millimeter.")

Because of its generally dark color it is somewhat somber for building stone[,] but [it] makes a very substantial structure. (The dark color does not affect its durability.)

In 1889 Charles Earle began a careful study of the material in the Princeton Museum[,] and in 1892 [he] published his memoir on the genus *Palaeosyops*.

No lead and manganese were [not] reported in these analyses and were evidently negligible. (It might be taken for granted that "no lead and manganese" would be negligible.)

DEFECTS IN LOGIC

Many sentences cannot stand the test of logical analysis, because their writers have not kept in mind the relations of all parts of the sentence to one another.

Unlike West Virginia, however, the sandstone strata thicken down the dip in Pennsylvania. (The word "strata" is not comparable with "West Virginia.")

The red berries induce violent illness in man, which is no hardship, since they are not at all palatable. (The writer meant that it is no hardship to refrain from eating the berries, but he said that violent illness is no hardship.)

The evidence of this one species is *unimportant, nor* [not important, and neither] is the deduction drawn from it by Mr. E.

The chalcopyrite followed closely upon chloritization and replaced *that mineral* [the chlorite].

The structure of the elongate ranges is so little understood *as to hamper* [that] any attempt to study the origin of the valleys between them [is hampered].

The topography has been so modified since the old glaciation *as to obliterate* [that] most traces of *morainal topography* [moraines have been obliterated].

FIRST OR THIRD PERSON

The first person is preferred to the third by many authors because it is more straightforward. Moreover, it prevents the ambiguity that may occasionally arise where "the writer" may be taken to refer to some other writer who has just been mentioned. Survey authors are free to use either person, however, so long as the use is consistent within any one report and so long as it is not ambiguous.

SINGULAR OR PLURAL NUMBER

Certain nouns may take either singular or plural verbs. The number of the verb is governed by the meaning of the sentence. If the thing, or group of things, or the quantity of material represented by the noun is viewed collectively as a unit, the verb should be singular; if the things are considered separately, the verb should be plural. The following sentences are correct:

The number of men employed was greater in 1915.

A large number of the men were injured.

He thinks that 30 cents is a high price.

Three dimes were placed on the table.

It is reported that 15 barrels of oil stands in the well (that quantity of oil stands in the well).

About 3,000 tons was produced in 1934. ("About 3,000 tons" means a quantity weighing, in all, about 3,000 tons; it does not mean 3,000 neat parcels each containing exactly a ton.)

At this place 20 feet of sandstone is exposed.

A series of studies was begun.

A series of studies were made. (It is desired to emphasize the individual studies.)

Several series of studies were made.

The United States protects its natural resources. (Although the term "United States" is treated as a plural in the Constitution, it is now generally used in the singular.)

The names of business firms are treated in the singular.

The Smith Co. announces; Smith & Co. announces.

"None" may be used in either a singular or a plural sense. It is singular when it means "not one," "no person," or "nobody." It is plural when it means "no persons" or "no things." "Not one" may be substituted for "none" in some sentences to express the singular.

None of the mines were open.
None of the ore contains gold.
None were injured.
Not one was injured.

RESTRICTIVE AND NONRESTRICTIVE CLAUSES

Critics differ regarding the use of the relative pronouns "which" and "that" to introduce the restrictive clause. However, the author will always be clear as well as correct if he uses "that" to introduce the restrictive clause and "which" to introduce the nonrestrictive clause.

A test of whether the clause is restrictive or nonrestrictive is to omit it. If its omission changes the meaning or results in a statement that does not make sense or is incomplete, it is restrictive. If it can be omitted without changing the meaning, it is nonrestrictive.

The restrictive clause should not be set off by commas, even if it is decided, for reasons of euphony, clearness, or emphasis, that a "which" is better than a "that" to introduce it. A nonrestrictive clause generally is set off by commas, but there are sentences in which, because of context or because of other punctuation, the nonrestrictive clause is not set off by commas.

In referring to a person, either "who" or "that" may be used. "Whose" may be used to designate things as well as persons, as in "The only State whose production exceeded * * *."

A phrase such as "and which," "and who," or "and whose" requires a preceding relative pronoun to justify the "and": "This district, [which is] the largest and which contains the principal mine, is in the western part of the county." The statement applies also when the conjunction "but" is used.

Where a restrictive clause is followed by an "and which" clause, both clauses take "which": "The district *that* [which] is the largest, and which contains the principal mine * * *."

The statements that have been made regarding punctuation of restrictive and nonrestrictive clauses apply also to phrases and apposi-

tives. Examples of restrictive and nonrestrictive modifiers are given below.

Clause

Measurements that are inaccurate are worthless. (Restrictive.)

The measurements, which were made by Jones, are inaccurate. (Nonrestrictive.)

They will start mining when the weather improves. (Restrictive.)

They will start mining in the spring, when conditions will be better. (Nonrestrictive.)

Participial phrase

The peak shown at the right-hand edge of the map is Mount Taylor. (Restrictive.)

The peak, rising high above the valley, is a famous landmark. (Nonrestrictive.)

Appositive

They were seeking the lead minerals galena and anglesite. (Restrictive. If the words "galena and anglesite" are omitted, the sentence means that they were seeking all the lead minerals, but they were seeking only galena and anglesite.)

They were seeking the lead sulfide, galena. (Nonrestrictive.)

REFLEXIVE PRONOUNS

Reflexive pronouns such as "myself" and "himself" should not be used for simple pronouns such as "I," "me," and "him."

Long, Williams, and *myself* [I] held a consultation.

The place was named by *myself* [me].

Lee believes that the locality [he] described *by himself* * * *.

VERB WITH PREDICATE NOUN

The use of "are" with a singular predicate noun or of "is" with a plural predicate noun, though it may be correct, is sometimes awkward:

The stony matter is [made up] largely [of] angular blocks of limestone.

The large accumulations of sawdust *are* [constitute] a serious danger.

The sandstone strata *are* [form] an example of the continental deposits in that area.

CHOICE OF WORDS

The aim of an author should be to focus the attention of the reader on substance rather than on style.

STILTED AND SHOWY WRITING

Stilted and showy writing tends to antagonize the reader. Moreover, it is not so easily understood as plain writing, it distracts attention from the thought, and it may give the reader who seeks useful information the impression that the report does not contain much. Some scientists and engineers are distinguished by the clear, simple

language of their reports. They do not refrain from using sharply defined technical words where clear-cut distinctions are necessary; but they do not, for example, write "phanerocrystalline" if "coarse grained" will express the meaning adequately, or "arenaceous" if "sandy" gives all the information needed.

Some members of the Geological Survey, if their manuscript reports can be trusted, never go anywhere—they invariably "proceed": "From this point the writer proceeded to Oshkosh"; "The party then proceeded westward." Neither do they "begin" work, they "inaugurate" or "initiate" it; and the work is not "done," it is "conducted" or "performed." Nor do they "get" or "obtain" information, they "secure" or "procure" it. If the area in which they are working is not large, they would call it not "small" but "limited" or "restricted."

The writer who is under the spell of authorship will write of "superficial circulation," meaning surface water or shallow subsurface water, or of "the vegetational aspect of the vicinity," or of "the ultimate nonanalyzed data of all happenings that may be apprehended"; or he may report that "the high-pressure area which collects over the Great Plains here accelerates the prevalence of westerly winds."

One author wrote of water samples being "withdrawn through ordinary garden hose by a portable manual pump." It would seem that a prosaic "garden hose" might well have been linked with an equally prosaic "hand pump."

Enthusiasm leads some writers to apply such terms as "splendid" and "beautiful" to fossils, exposures, specimens, and other things that have neither splendor nor beauty in the primary sense of the words. It is easy to find more appropriate terms, such as "excellent," "remarkable," "well exposed," or "well preserved."

"Inaugurate" and "inauguration" can be used for appropriate occasions; "initiate" is a good word to apply to ceremonies in secret societies, or, judiciously, to some other things; and "secure," associated in thought with security, should be used in the sense of "make fast" rather than of "get," "obtain," or "procure."

Authors would do well to avoid use of "limited" and "restricted" for "small," "scant," and "slight." A better use of "limited" is found in such sentences as "Sandbags piled along the railway limited the floodwaters to the eastern part of the town."

EXACT WORDS AND PHRASES

It should be the aim of the Survey author to choose words that have exact meanings or to which exact meanings can be given. In doing so he is helping to make his language more useful for conveying information, which is the principal purpose of his writing. But, in

doing so, he is fighting an uphill battle. English is a live and growing language, and one in which the correct usage of a word is determined more by the way the public chooses to use it than by the intention of the writer introducing it or defining it for a particular use. The Survey author, therefore, finds it necessary to compromise between too great and too little an effort to achieve precise definitions of, and fine distinctions between, words that the public is inclined to use broadly and indiscriminately.

A number of

The phrase "a number of" is overworked by many writers. It is usually intended to mean an indefinite small number, but as 5,000,000 or 50,000,000 is also "a number" it is preferable to use an appropriate and more specific substitute, such as "several" or "a few."

Accountable to

"Accountable to" is improperly used where there is no accountability, as in "The conglomerates are all *accountable to* [a result of] one general period of uplift." "Accountable" is used correctly in "Jones was accountable to Brown for the field equipment."

Ago, since

"Ago" and "since" should be discriminated. "Ago" refers to a point in past time, as in "The volcano erupted 20 years ago"; "since" refers to the time intervening between such a point and the present, as in "It has been 20 years since the volcano erupted." (See also "Last year, this year," p. 163.)

Some writers use "since" ambiguously. In each of the following phrases the "since" on first reading might be taken to indicate time and should be replaced by "because":

Since these experiments were made to determine the order of solubility of the compounds studied, * * *.

Since the war in Europe has affected ocean transportation, * * *.

Since the Snow Storm mine ceased production and the Lost Packer mine shipped only a few cars of matte, the increase during the year was due to * * *.

In the following example there is not much chance that "since" would be taken to indicate time, but the use of "because" would remove any possible ambiguity:

Since the water was rising, they moved the supplies.

"Since" is used properly in the following example, in which it could not be taken to indicate time:

Since water in nature is never completely free of ionized constituents, its conductivity is always at least a little greater than that shown for pure water.

By convention, "since" is generally used instead of "because" in mathematical development:

Since $a = b$
and since $b = c$
then $a = c$

Aliquot, aliquant

"Aliquot" is a noun meaning a divisor that leaves no remainder, an adjective designating one of the equal portions into which a dividend is divided, and a verb meaning to divide into equal portions without leaving a remainder. Thus 5 is an aliquot, or an aliquot portion, of 15. "Aliquant" is an adjective designating a divisor that leaves a remainder. Thus 5 is an aliquant portion of 16.

Altitude, elevation

Both "altitude" and "elevation" are used in referring to distance above sea level, but "elevation" also means uplift and is used in that sense in many geologic reports ("elevation of the two areas to their present altitudes"). "Altitude" is preferable for indicating distance above sea level. However, "elevation" is a well-established term in industry and among engineers, and their use of "elevation" for "altitude" is followed appropriately in many Survey reports. The terms should not be used interchangeably in the same report. If "elevation" is used for indicating distance above or below sea level, it should not be used in the same report for indicating uplift; use "uplift" for the latter.

And/or, and (or)

The expression "and/or" is used in contracts and legal documents but is rarely used in Survey reports. If it is necessary to use the expression, the "or" is generally enclosed in parentheses: "and (or)." Often "or" can be used alone, and the context will make clear that "and" also is to be understood: "In some places the monotony of the shale is relieved by the presence of sand or gravel." (Obviously, in some of the places sand and gravel likely are present. Alternatively, "or both" may be added: "The sequence may include limestone or sandstone or both.")

As well as

The term "as well as" gives a slight additional emphasis to what precedes it compared with what follows it; where no such emphasis is desirable "and" should be used instead.

Based on, on the basis of

Care is needed to distinguish the participial phrase "based on" and the prepositional phrase "on the basis of." The former modifies the noun in the main clause of the sentence; the latter modifies the verb.

Based on [On the basis of] measurements made on photographs, Brown estimates * * *. ("Based on" would modify "Brown.")

Brown's estimates were based on measurements made on photographs.

Even where grammatically correct, a "basis" phrase may be less desirable than a concrete phrase.

The rocks on the basis of [If classified by] size of grain [the rocks] may be divided into sandstones and conglomerates.

The conclusions stated seem to be warranted *on the basis of* [by] the data presented.

Begin and open, end and close

The verb "open" means primarily to move something from its shut position; the opposite verb is "close." This pair and the corresponding nouns "opening" and "close" are often used in a figurative sense where "begin" (or "beginning") and "end" would be more nearly exact and therefore preferable, on the general principle that a word that has only the intended meaning is better than a word that has several meanings.

In this subarctic region the mining season *opened* [began] about the middle of May and *closed* [ended] 4 months later; however, somes mines were opened earlier and were not closed until the first of October.

Color terms

Definitions of color used by geologists in describing rocks should be so specific in meaning that there can be no doubt in the reader's mind. Exact color descriptions can be found in the "Rock Color Chart" prepared by a committee of the National Research Council in 1948. The chart shows samples of various colors and defines each color as to hue, value, and chroma, using both words and symbols. Many geologists and some nongeologic organizations use this or similar charts. The author should indicate early in his paper whether he is using the "Rock Color Chart." If he uses it, he should do so consistently. If he does not use it, he should use other terms that convey a clear meaning to the reader. "Olive drab," "apple green," "royal blue," and similar terms may convey meanings that are sufficiently definite to make their use appropriate, where more exact designations are not required.

Combination color terms, like the three terms just mentioned, are separate words, but such terms are hyphened when they are unit modifiers:

bluish green	bluish-green feathers
dark green	iron-gray sink
orange red	silver-gray body

Compass direction

Terms of compass direction, such as "west," "western," "westerly," and "westward," are used indiscriminately by some writers. The adjectives "west" and "western" both may be used, but each should be used consistently in a particular sense throughout a report. Indefinite or general terms of broad application may end in "ern," as "in the western part of the district"; terms of definite designation need not, as "west bank, side, end, corner, edge."

"West" is an adverb also, as in the sentence "The fault strikes west" (or "westward"). "West" may be used to indicate approximate direction, meaning anywhere between west-northwest and west-southwest. Exact direction can be expressed by saying "due west" or by giving the deviation in degrees from due north, as "N. 75° W." Puzzles in direction appear in many reports:

About 8 miles north and a little west of Weatherford.
About 100 miles south of west of this * * *.
In a ravine 1½ miles west and a short distance north of Hanover.

If roads are laid out along section lines, so that a place cannot be reached by a diagonal, directions to reach the place can be stated as "Drive 10 miles north and then 2 miles east."

The adjective "westerly" is used properly in such phrases as "westerly dip, direction, trend." Although it is also an adverb, its use in the following sentences is not so desirable as the use of "westward":

The fault extends for an indefinite distance *westerly* [westward].
The stream here turns *westerly* [westward]. (Not "westwardly" or "to the westward.")

"Westward" also is both an adjective and an adverb. It is used properly in the unit modifiers "westward-dipping, -trending, -flowing" and as an adverb in "extends westward." The adverb "westward" means toward the west, or in a general westerly direction. In the sentence "Clay is abundant in this formation at Newton and westward," the latter part might better be written "at and west of Newton."

Contour, contour line

In text, it is desirable to make a distinction between "contour" as applied to the surface of the earth and "contour line" as applied to a topographic map.

The greater resistance of the Paleozoic rocks is indicated by the contour (or contours) of the hills.
On the map the 1,000-foot contour line is near the shore of the lake and extends a few hundred yards up the river.

General usage among engineers allows use of "contour" instead of "contour line" if a specific contour is mentioned.

In a map explanation, where there is no possibility of misunderstanding, the word "contour" may stand for "contour line," as in the explanation beneath the symbol for a contour line: "Contours drawn on top of Precambrian rocks; interval, 500 feet" (omit final period on maps).

Numerals indicating altitude (or elevation) on contour maps, and similar numerals on other illustrations, by convention are printed without a comma if they are of 4 digits; they are printed with a comma if they are of 5 digits or more. In text, however, numerals of 4 digits or more are printed with a comma.

Develop, development

"Develop" and "development" are used by many writers in too many senses. "Developed" is used to mean occurred, formed, exploited, worked, mined, or almost anything else that may happen to be in the mind of a writer who will not take the trouble to think of the word he really needs. A few of the diverse uses and misuses of "developed" and "development" are shown below.

In this district ore bodies of considerable *importance* [value?] have been *developed* [formed? worked?].

Here the vein is *developed in greater thickness* [thicker].

The *large development* [great thickness] of Triassic sediments in this region.

It is possible that its development was in Tertiary time. (Write, "It was formed perhaps in Tertiary time.")

This differs from the underlying formation in the absence of andesite and in the *development* [presence] of thicker masses of slate.

Barren gossans *developed at depth yielded* [were found to be underlain by] good deposits.

There is much lateral variation in the *development* [thickness? character? composition?] of even the most persistent strata.

At the crest of the hill the conglomerates are *typically developed* [exposed in typical form? exposed in typical character and thickness?].

These salt pseudomorphs were observed on the south slope of the mountains, where they are *more prominently developed* [more numerous? more conspicuous? more nearly perfect?] than elsewhere.

The body of shale above the Dakota sandstone was named the Mancos shale on account of its characteristic *development* [exposures] in the Mancos Valley. (Write, "* * * was named the Mancos shale, from Mancos Valley, where it is typically exposed.")

In its typical *development* [phase?] the formation is a series of dark clay shales.

Neither the limestone nor the sandstone layer is *developed with sufficient uniformity* [sufficiently uniform] to be traced for considerable distances.

In some places the quartz *is developed* [occurs? appears?] in anhedral grains.

Building stones are *better developed* [more common? occur in greater quantity?] in adjacent quadrangles, and it seems probable that those of this area will not be much *developed* [exploited? quarried?].

Here the plants of the century family attain their *greatest development* [largest size? densest growth and largest size?].

These plants are here *present in less abundance and in more stunted development* [less abundant and smaller].

"Develop" and "development" have a special meaning in the mining industry. To develop an ore body is to do the work necessary to show its extent; to develop a mining property is to do the work necessary to open up the ore bodies. The work done for these purposes is development or development work.

"Developed" and "development" are used properly in the following sentences:

It is the only deposit that has been developed.
The development of the deposit will soon be undertaken.
The company began to develop the mine.

"Develop" and "development" have a particular meaning in water-well construction also. To develop a well is to remove, by any of several means, fine-grained material adjacent to the drill hole so that water can enter more freely. "Develop" and "development" are used also in referring to the exploitation of ground water.

Large supplies of ground water are developed in this area.
The ground-water development in this area is intensive.

Doubled-up "have," "be"

Mark Twain, in his book "A Tramp Abroad," states:

Harris said that if the best writer in the world once got the slovenly habit of "doubling up his have's" he could never get rid of it—that is to say, if a man gets the habit of saying "I should have liked to have known more about it," instead of saying "I should have liked to know more about it," his disease is incurable.

The doubled-up "have," "has," and other auxiliary verbs are occasionally seen in manuscripts of Survey writers, as in the following sentences:

This gravel *has the appearance of having* [looks as if it had] been deposited by moving water and *has a strong resemblance to* [strongly resembles] the Gila conglomerate.
The known geologic history of the region *may be said to have been begun* [begins] in Silurian time.

On the other hand, "to be" is often omitted where it should be used, as in these sentences:

Cap Glacier is reported [to be] a thin névé field.
The submarine topography appears [to be] chiefly the result of glacial erosion.

"Have" and "has" should be used as the principal verb, with discrimination. "Has" should be used in place of "contains" in the sentence "This water contains a higher mineral content," but "have" and "has" are used undesirably in the following sentences:

The deep erosion gives evidence that the rocks *have a* [are of] considerable age.
The alluvial soil *has* [contains] much sand and gravel.
The rocks *have a flesh color* [are flesh colored].
The sample had *had no exposure* [not been exposed] to the air.

This form has the width 2½ times less than the length. (Can be written, "The length of this form is 2½ times the width.")

In the matter quoted below almost everything mentioned "has" something or seems to "have" something.

The rocks have a typical schistose structure. The planes of schistosity have a dip that seldom departs greatly from the vertical. The schistosity has a trend that is generally northwestward. The rock has a dark-gray color, and its surfaces have a satinlike luster.

In this matter only one "have" is needed, and perhaps even that one can be spared. The author's choppy and badly written sentences contain 43 words; the edited form below contains only 28 words and expresses the same ideas better, without choppiness.

The rock is typically schistose, and its planes of schistosity generally stand almost vertical and trend northwestward. It is dark gray and its surfaces have [show?] a satiny luster.

Due to, owing to

A simple grammatical rule will clarify the use of "due to" and "owing to." "Due to" is used as an adjective and must refer definitely to a noun or to a word group used as a noun; "owing to" modifies a verb.

A safe general rule for use of "due to" is: Use some form of the verb "to be" before it or place it next to the noun it modifies.

Damage due to the cloudburst was extensive.

Damage was due to the earthquake.

The Whittier School was damaged by the earthquake, owing (not due) to the fact that the building stood on made ground. ("Because the building stood on made ground" is equally clear and less cumbersome.)

The line of strike of each fault is very crooked, *due* [owing] to the fact that the faults traverse a rugged country. (Or better, "because the faults traverse * * *.")

This energy is immediately due to gravitation, but it is remotely *owing* [due] to the sun's heat.

Due to [Owing to, Because of] irrigation, the discharge had increased *by 1917* to 5,000 cubic feet per second [by 1917].

"Due to" is correct where "attributed to" could be used. "Owing to" is correct where "because of" could be used.

Encounter

In its primary sense "encounter" means to meet with hostile intent or to meet face to face. It is commonly misused as follows:

The samples were *encountered* [found] near Red Rock Lake.

The formula was *encountered* [found, seen, discovered] by Jones in a textbook by Smith.

The effect has been *encountered* [observed] in samples from placer deposits.

The word is used correctly as follows:

Jones encountered a brown bear in Alaska during the field season of 1956.

Jones encountered Smith near the main road.

Their encounter on this subject during the meetings of the society caused a mild stir among the members.

Endings "ic," "ical"

An interesting feature of a manual published in 1892, "Suggestions for the Preparation of Manuscript and Illustrations for Publication by the U. S. Geological Survey," by W. A. Croffut, was an attempt "To insure uniformity of practice in the spelling of a large class of scientific words ending in ic and ical, as geologic, geological * * *." It suggested: "(a) Terms designating natural phenomena, relations, conditions, products, etc., may end with ic. (b) Terms designating the works of man—research, literature, speculation, etc.,—may end with ical." Accordingly, the usage would be as follows: Geologic formation, but geological survey; geologic structure, but geological map; geologic relations, but geological report. This suggested usage seems to have been abandoned in later years.

In some current reports the endings "ic" and "ical" are used indiscriminately: topographic, topographical; geologic, geological; petrographic, petrographical; paleontologic, paleontological; mineralogic, mineralogical. Uniformity in the use of a given term is desirable in a single paper. The current tendency is toward the use of the shorter form, but the longer form of the word, if much commoner than the shorter, need not be shortened just for the sake of shortening. Moreover, both forms of some words may have to be used on occasion, as when a writer may prefer "geologic studies" but is not free to write "Geologic Survey."

Enjoy, suffer

To ascribe human qualities to inanimate objects is appropriate enough in poetry, but it seems a little farfetched in a scientific paper. The author who wrote "Similar forms in humid climates suffer basal steepening and may therefore enjoy accelerated backweathering" might better have written "Similar forms in humid climates become oversteepened at the base and therefore may weather back rapidly." The correction, besides getting rid of the undesirable use of "suffer" and "enjoy," gets rid of the clumsy terms "basal steepening" and "backweathering."

"Suffered" is misused in the following sentence:

The rocks have *suffered* [undergone] deformation (or better, "have been deformed").

Evidence, evidenced

"Evidenced," a word to be avoided, is used for "shown," "indicated," "proved," or "evinced"; and "evidence" is much overused.

An explorer says, "No fossil evidence was found in the limestone," meaning no fossils, or no traces of fossils. Note also, "These beds are entirely recrystallized and [contain no traces] *evidences* of organic remains *are lacking*," a badly written sentence in which continuity and proper emphasis are lost by an unnecessary change of construction. Instead of saying that a certain conglomerate contained pebbles of limestone, a geologist wrote, "In this conglomerate limestone pebbles were in evidence."

Except, excepting, exceptions

"Except" is shorter and generally better than "excepting." "Exceptions" should have a logical relation to something expressed in the sentence. In "The coastline is, with few exceptions, rocky," it is not the coastline to which there are exceptions. Write, "Except in a few places the coast is rocky."

Featheredge, knife edge

The terms "featheredge" and "knife edge" may be applied to the edge of a rock unit that thins to extinction. The terms are no longer used as a substitute for zero in describing a range in thickness: "The unit ranges in thickness from 0 to 13 feet," not "The unit ranges in thickness from a featheredge to 13 feet." (See also "Range, vary," p. 166–167.)

Following

The participle "following" is undesirably used for "after," as in the sentences "Following this there was a second period of uplift"; "Following the completion of this work nothing further was done." This use of "following" may be due to contagion from bad practice, as in the sentences "Mr. Kellerman went West following a prolonged illness"; "O'Brien left the place following his dinner." The phrase "during and following the interval" is objectionable both because "following" is not a preposition and because the similarity of ending makes "during" look like a participle.

"Following" is properly used as an adjective in the sense of "succeeding," as in the sentence "They began work on the following day," or to indicate something that is to follow immediately, as in "The analyses are given in the following table."

Former, latter

"Former" and "latter" are often misused. They should not be used where the reader will have to look back to find what they mean. A good general rule, instead of using them, is to repeat the words to which they would refer. Of course "former" and "latter" cannot be used if there are more than two antecedents, as in the sentence "The granite consists of quartz, orthoclase, and biotite, the former con-

stituting two-thirds of the rock." Some writers use these words without reason, as in the following sentences:

The quartz veins lie near bodies of muscovite-biotite granite, *the latter being* [which is] probably the youngest rock in the region.

The mines and the smelter were operated until the first of November, the *latter* [smelter] treating an average of 360 tons daily.

Most such deposits contain calcite, and where they carry copper-iron sulfides the latter will oxidize to carbonates, silicates, and oxides. (Write, "Most such deposits contain calcite, and any copper-iron sulfides they carry will oxidize * * *.")

Writers sometimes use the words in a way that conceals the intended meaning, which must be guessed or inferred from the context. Examples are given below.

The concentration of the sulfide ion is so greatly affected by change of acidity that *the latter* [this change] is the principal factor determining the precipitation of sulfides.

One of the purposes of the reconnaissance was to examine certain prospects containing ores of uranium and vanadium, and it is to *the latter* [these ores] that this report is confined. (The context shows that "the latter" means the ores of both uranium and vanadium.)

The house and chimney swing with different periods under the impulse imparted by the ground, and the *latter* [chimney] is broken off, usually at the roof line.

"Former" and "latter" have no proper antecedents in the following sentences:

I have seen all the phenomena herein described but have minutely studied only small parts of them. It would be impossible for any one man to do the latter unless he made it a life task.

In color the chrysocolla ranges from reddish brown to brownish black; in a few places it is light blue. The *latter* [blue chrysocolla] has a vitreous luster and is crystallized, but the *former is* [brown varieties are] dull and in most places amorphous.

From these sentences, the reader can see why many careful writers decline to use "the latter" and "the former," even where to avoid them is troublesome.

Graphs

In describing the method of plotting a graph, the author should distinguish between the relationship of the axes and the type of scale used. The axes may be rectangular, triangular, isometric, cylindrical, or polar. Commonly used scales include arithmetic, logarithmic, and probability. The term "log-log" means logarithm of a logarithm, such as the scale on a log-log slide rule, and should not be applied to a simple logarithmic scale. The term "semilogarithmic" does not describe a single scale; it is a term applied to plotting paper that has a logarithmic scale on one axis and an arithmetic scale on a second axis, usually at right angles to the first.

Horizon

"Horizon" is improperly used for "bed" or "stratum," as in the sentence "This horizon is 4 feet thick." The term "horizon" denotes merely position. A horizon has no thickness, being merely a stratigraphic level, or plane. In the following sentences "horizon" is used improperly:

Several thin *horizons* [beds] are resistant and stand out prominently.

The total thickness of the *horizon that carries the conglomerate* [conglomeratic beds] is 20 feet.

However, "horizon" is properly used for a zone having thickness when applied to soil. By virtue of universal usage, the "A horizon," "B horizon," etc., of soils refer to definite zones.

Important, interesting

"Important," "importance," and "interesting" are greatly overused by some writers. As a rule, "important" is not the appropriate word unless it is accompanied by some term denoting why or how the the thing described is important, as "commercially important." It should not be used for "large," "abundant," "conspicuous," "valuable," or other words of clearly defined meaning. "Interest" is a mental attitude of the observer, and the adjective "interesting," though applied to an object, relation, or other phenomenon, describes only the observer's relation to it. For clear thinking as well as clear writing, a writer should fortify the use of "interesting" or "important" by pointing out the relation which endows the indicated phenomenon with interest or importance. When that has been done the need for the adjective often disappears.

The following examples show some remedies for this overuse:

The *most important* [best? most frequently traveled?] route across the region * * *.

The most *important* [abundant] igneous rock in this area * * *.

These streams, named in the order of their *importance* [size? accessibility?], are * * *.

Improvement

The word "improvement" means betterment; it should not be used for a change that is not necessarily a betterment, as in "The streamflow *showed improvement* [increased]." However, it would be correct to write, "Operation of the reservoir resulted in an improvement (increase in regularity) in streamflow."

In question

The phrase "in question" is used by some writers concerning matters that are not at all in question, as "The lake in question," for "The lake mentioned" or simply "This lake."

Interval

Generally, "interval" should be used in its usual sense of a space of time between the recurrence of similar things or states, or a space between things, a void between objects. In some contexts, "interval" is the distance between two horizons, measured normal to them. It is applied not to the rocks but to their thickness. Do not write, "The interval consists of sandstone and shale"; but write, "The rocks in this interval consist of sandstone and shale." A covered, concealed, or missing interval of rocks may be indicated in a well log or in a measured stratigraphic section.

Last year, this year

An author should avoid the use of phrases like "last year," "this year," "next year," "3 years ago." Before the report is printed "this year" may have passed, and "last year" may be "2 years ago." Write "in 1957"; "during the field season of 1957." See also "Ago, since" (p.152–153).

Leaser, lessee

"Leaser," a term used by some miners for "lessee," may be understood by others as meaning either "lessor" or "lessee." Use "lessee."

Majority

"Majority" is used improperly for "most" in many manuscripts. If the writer means about two-thirds, three-quarters, or nine-tenths he can use those fractions. Do not apply "majority" to a substance that is weighed or measured, as "the majority of the manganese."

Many, numerous

"Many" and "numerous" are not exact synonyms. "Many" implies vaguely more than a few, as in "Many sources of information should be consulted." "Numerous" implies a noticeably large number, as in "The President receives letters from numerous persons." Sometimes it connotes a crowding or thronging, as in "On a clear night one can see numerous stars." If "numerous" is used to mean "many," the latter word is preferable because it is shorter.

More or less

"More or less" is an expression that is much overworked. It may be permissible to say "The results are sure to fluctuate more or less." But it definitely is wrong to say "The pink color fades more or less vertically upward," or "This situation is more or less unique in many respects." Nothing can be more than vertical or more than unique. As a general rule this expression should be avoided, or should be used only in the sense of "to a somewhat greater or lesser degree."

Occur

The word "occur," in the sense of "appear" or "be present," is a proper and useful word, but it is used in many places where other words would be better. It should be kept in mind that the word carries some connotation of randomness—something happening or existing without design. There is no good reason for using it in sentences like these—

Trees *occur* [grow] on these slopes.

The mines *occur* [are] in Pope and Hardin Counties.

Waterfowl *occur* [are found] here in enormous numbers.

A well-exposed occurrence of dolomite sheared and made slaty by faulting *occurs* [is well exposed] north of Pequea Creek.

Outcrop, crop out

Because the noun "outcrop" may be mistaken at first sight for the verb "outcrop" (as in "The rock outcrops in the stream bed are surrounded by gravel"), the form "crop out" is preferable for the verb.

Over, under

"Over" and "under" are used in some phrases where "more than" and "less than" or "fewer than" obviously would be preferable. The use of "over" in the sense of "more than" and of "under" in the sense of "less than" or "fewer than" is not incorrect, but "over" and "under" should not be used where they might be confusing, as they are in some of the following sentences:

The burning has advanced along the coal bed for a distance of over 1,000 feet and under 1,000 feet of overlying material.

The ore mined generally lies under more than 20 feet, and in some places over 100 feet, of sand and clay overburden.

The dolomite dips eastward under over 20 feet of muscovite-biotite schist.

Even under the best conditions it was not profitable to mine coal under 2 feet thick or over 200 miles from market.

"Upward of" is also used undesirably for "more than," as in "The project will cost upward of a million dollars."

"Over" or "above" may be used in a misleading sense in such sentences as "Oxidation extends to depths *above* [below, of more than] 2,100 feet."

Part and portion, partly and partially

"Part" is generally preferable to "portion," and "partly" to "partially."

"Part" is a fraction or constituent of a whole; "portion" primarily means share and as contrasted with "part" denotes an entity taken from a whole. In Survey writing, use "part" unless there is clearly the idea of apportioning or sharing. "Partly" is used correctly where the meaning is "in part," and "partially" is used correctly where the

meaning is "in some degree or measure" or "to some extent." "Partially" metamorphosed is better than "partly" if it refers to degree, as it generally does. Note the proper use of the above words.

The fieldwork was done during the first part of the month.
Part of the soil was sampled.
Gold was found in the southern part of the mine.
His portion of the estate was $50,000.
The portion of the area set aside for that type of investigation was too small.
Their portion of the appropriated water was to be used for irrigation.
The valley is partly filled with silt, sand, and gravel.
The rock is partially weathered.

The term "partial analysis," meaning an analysis that is incomplete, may be used. It is understood in the analysis of a sample of water, for example, that not all constituents were determined—not that the determination of any one constituent was incomplete.

Penetrate

It can be argued that only an object like a drill or a projectile can penetrate. By virtue of long usage, however, it can be said that a well, or a hole, penetrates a rock.

Prefixes "pre," "post"

The prefixes "pre" and "post" are used with time verbs or their derivative nouns to mean "before (or after) in time, previous (later)." When these prefixes are affixed to nouns or adjectives they mean "before (or after), front (hind), anterior (posterior)."

Thus it is correct to say—

pre-August sale	not "pre-Sears Roebuck sale"
postconstruction litter	not "posthouse litter"
precrystallization joints	not "precrystal joints"
prevolcanism erosion	not "prevolcanic erosion"

Geologic time terms may be used with these prefixes, as, "pre-Jurassic," "Precambrian," "post-Mississippian." Two-word terms, such as "pre-Elk Mountains," "post-Judith River," "pre-Tacoma Gulch," are awkward and should not be used.

The brevity attained in the use of prefixes sometimes detracts from clarity; and in many sentences coherence is enhanced by using a few more words to express the exact meaning.

Production

Such expressions as "the well failed to reach production" and "the area beyond production" simply befog meanings and dull the edges of distinctions. "Production" means the act of producing or the amount produced, as in the following:

They hastened production during the emergency.
The production of gold increased.

The initial production was 300 barrels per day.
Production increased after the war.

Proposition

A "proposition" is something propounded, and it generally should be restricted to formal statements in mathematics or logic, to the draft of the terms of a business agreement, and such. It does not mean the matter, undertaking, task, prospect, area. "These dikes are possible large low-grade propositions" is not good usage.

Proved, proven

"Proved," not "proven," is the preferred form of the past tense and the past participle of the verb "prove."

As an adjective, "proven" (from the Scotch) has been used by many reputable writers, but the variant form seems unnecessary.

Quite

Some writers use "quite" for "very," "somewhat," or "rather," or use it superfluously. Phrases like "quite large," "quite a distance," "quite a few" should be avoided. "Quite" should be used in its primary sense, to mean "entirely" or "completely," as in the phrases "quite conclusive" and "not quite finished." "White plastic clay quite free from sand" is a correct use in which "quite" means "wholly" or "entirely"; its omission would be preferable.

Range, vary

In expressing approximate size, well-known objects can be used for comparison, even though these objects do not occur in exact sizes. For example, one may say loosely "The pebbles were the size of walnuts." In giving a range, however, such terms are too indefinite; the ends of the range should be expressed in some unit of measurement, such as an inch or a centimeter. (See also "Featheredge, knife edge," p. 160.)

The phrase "in thickness" and not the adjective "thick" must be used after "ranges." Write, "The bed ranges from 40 to 50 feet in thickness," "The bed ranges in thickness from 40 to 50 feet," or "The bed is 40 to 50 feet thick."

If only the upper limit is to be given, the form "as much as," or "reach a maximum of" can be used, as in "The granite contains phenocrysts of microcline 'as much as' 2 inches in length" and "The pebbles reach a maximum diameter of 6 inches." "Range" should not be used unless both limits are given; in the sentence "The pebbles range up to 6 inches in diameter," substitute "are as much as" for "range up to."

In a statement of range in size or price, only two limits should be given. "The price ranges from $11 to $17 and $18 a ton" should read "from $11 to $18 a ton." Such sentences as "Its thickness ranges from 35 feet or less to 175 feet or more" conveys no exact information and should be avoided. Write instead, "Generally ranges from 35 to 175 feet," which implies that locally the thickness may be greater than the maximum or less than the minimum of the range specified.

Care should be exercised in the use of zero, as zero is significant when it is used to indicate a measurement. (See p. 99–100.) A reader who is told that two coal beds are "separated by 0 to 6 inches of bone" may wonder how great a separation would be made by 0 inch of bone. However, in the sentence "The coal bed ranges in thickness from 0 to 6 feet," it should be obvious that the range is from nothing to 6 feet.

"Vary" should be reserved to indicate variations or fluctuations like those meant in the sentences "The flow of the well varies," "The stream varies in width," "The tide here varies greatly in height," "The bed is of varied thicknesses." In the sentence "The wells vary from 100 to 300 feet in depth," "vary" should be replaced by "range." However, "The water level in the well varies with the season" is correct.

Red beds

Except when quoting from another publication, use "red beds" (two words, lowercased) instead of "Red Beds" or "redbeds" for the rocks of Permian and Triassic age, and similar rocks of other ages, to which these terms are customarily applied. The words "red bed" of course are hyphened when used as a unit modifier, as in "typical red-bed exposures" or "characteristic red-bed lithology."

Section, area, region

"Section" is a word of many meanings. Its use in the sense of "area" or "region" should be avoided; the "section" of one sentence is likely to become the "region" of the next, as in the following example:

> This mine is in the largest lead-producing section of Canada. This region is mountainous.

In geologic reports, "section" may be reserved with advantage to designate a land section, vertical section, cross section, and thin section, and perhaps for a few other uses; and "place," "locality," "area," "quadrangle," "district," or "region" may serve as geographic terms. If a distinction is needed, use "region" for the larger unit and "area" for the smaller.

Standpoint, viewpoint, point of view

The phrase "from the standpoint of" is overused by some writers. In the phrases "from the standpoint of coal mining" and "from the viewpoint of roadbuilding," "coal mining" and "roadbuilding" are used for "the coal miner" and "the roadbuilder." "From the point of view of farming" means "from the farmer's point of view"; the farmer, but not farming, may have a point of view. "Viewed from the standpoint of age these rocks are Miocene" is a bad equivalent of "These rocks are of Miocene age." "The value of the land from an agricultural standpoint" means simply "The value of the land for agriculture" or "The agricultural value of the land." "An attempt to frame a working hypothesis from an atmospheric standpoint" leaves the reader somewhat "up in the air" as to the meaning intended. Some authorities distinguish between "viewpoint" and "standpoint." "Point of view" and "viewpoint" imply that the view is an opinion or personal judgment. "Standpoint" suggests a basic principle or body of principles. The terms generally are used interchangeably, however, and "point of view" has long been idiomatic, and probably is best.

Additional examples follow.

From a genetic point of view [The genesis of] the coralline limestones *have* [has] been more carefully studied.

This is too important a matter to be treated *from a careless point of view* [carelessly].

From the standpoint of [According to] this theory * * *.

The ridge is symmetrical *from a topographic standpoint.*

A flora which is of great interest *from a comparative paleobotanical standpoint* [to the student of comparative paleobotany] * * *.

[Considered geologically] The range can be divided into two parts *from a geological standpoint.*

If any such minor folds are present they are important *from the oil and gas standpoint* [in relation to the occurrence of oil and gas].

Structure

"Structure" is used to denote the attitude of the rocks of a region or area as a whole. An individual "structural feature" may be an "anticline," "dome," "terrace," "fold," or one of many other features. "Structure" is used as a synonym for "structural feature" in some legal and business practices, but this use is generally avoided in Survey reports.

Such

"Such" is used by many writers where "so" would be preferable, as in the following sentences:

The water occurs in alluvial sand *of such fineness* [so fine] that ordinary well screens are of no use.

These boulders are *of such size* [so large] * * *.
The time expended in the fieldwork was *such* [so short] * * *.
The deposit is *of such hardness* [so hard] * * *.

Temperature

"Cold temperature" is used erroneously by some authors instead of "low temperature" or "cold weather." Similarly, "hot temperature" should be avoided.

Terms denoting time and place

Adverbs or adverbial phrases that by strict definition should apply to time—such as "often," "sometimes," "at times," "always"—are used by some writers instead of words or phrases denoting place, as in the following examples:

[Many of] These fissures *often* intersect.
[Many of] These phenocrysts are *often* deeply corroded.
[Some of] These crystals are *sometimes* an inch in diameter.
[Some of] The volcanoes are *sometimes* practically extinct.
The complexity of the folding is *sometimes* very marked [at some places].
Pyrite is less common than marcasite, although it does occur *at times* [at some places].
These rocks are *nearly always* red [at most places].
[Many of] These terraces are *frequently* covered with gravel.
[Few of] These pebbles *almost never* have striated faces.
[Most of] These pebbles are *usually* light gray, although some are light yellow.
The moraine is *rarely* less than a mile wide [in a few places].

"When" is often misused for "where," as in the following sentences:

When [Where] the thickness is greatest it is 250 feet.
The ore was richest *when* [where] it was most altered.
The limestones range in color from light gray *when* [where] fresh to pale yellow where exposed to the weather.

To be

The verb "to be" has three uses: as an intransitive verb indicating being or state of existence, as a linking verb, and as an auxiliary verb. It is properly used in these three sentences:

Below the summit plain are valleys that have gently sloping sides.
The remnants are on opposite sides of the fault.
The front tapeman should be a man of experience.

When "be" is an auxiliary verb, the principal verb should not be omitted.

The towns are all [built] on the second terrace.
Tarnish on copper is [formed] by oxidation.

Use of prepositions

The use of a preposition following a verb to express an idea that can be conveyed by some other verb alone may lead to the undesirable doubling of prepositions.

The conditions *met with* [observed, prevailing] in the field * * *.
A large production is not to be *looked for* [expected] from these deposits.

Examples of undesirable doubling and tripling of prepositions follow:

A thickness of *from* 2 to 4 feet * * *.
An estimate of the cost of *the operation of* [operating] the filter * * *. (In most such phrases a noun ending in "tion" and the "of" following it should be replaced by a gerund.)
Following the discovery of the character of this deposit * * *. (Write, "After the character of this deposit was ascertained * * *.")
Each of the veins has been drifted on for from 50 to 70 feet. (Write, "Drifts have been run 50 to 70 feet on each vein.")

Value

"Value" in its abstract sense means the worth or desirability of something. In the mining industry it is used to mean the metals or minerals of value in the ore, but in formal reports on mining its use generally should be avoided because it may lead to ambiguity. In "Lead and zinc values are nearly equal, and their total exceeds the value of gold," it is not certain whether "values" refers to the percentage of the metals or to the dollar value. "About 150 feet below level 6 the ore carried high values in silver and gold, some lead, and 10 to 25 percent excess silica" is ambiguous. In mathematics and statistics, "value" means any particular quantitative determination, as the different values of a variable.

Various, different

"Various," meaning "different" or "diverse," is misused for "many" or "several," as in the sentences—

Gold occurs here and there on the ocean beach and *various* [several] attempts have been made to recover it. (Unless various methods were employed.)
Native arsenic was found at *various* [several] places.

"The rocks are of various colors" is correct.

"Different" is sometimes used carelessly instead of the precise word, as in "I telephoned him different times" when the writer means only "I telephoned him several times." "Different" is used also in some places where it is unnecessary, as in the following sentences:

The ore occurs in several *different* mineral groupings.
Several *different* phyla are represented.

However, "different" may be used properly if degree of difference is to be expressed, as in "very different phyla."

Verbal, oral

"Verbal" refers to words. It is used improperly for "oral," which means "spoken." "Verbal" is properly used in the sentence "The differences between the two accounts are only verbal"—that is, the ideas are practically alike, but the words are different. Communications of unpublished information should be called "written," or "oral," but not "verbal." In the following example "verbal" is used correctly:

The text contained two explanations, one verbal and the other mathematical.

Vicinity of, neighborhood of

"In the vicinity of" and "in the neighborhood of" are used unnecessarily for "about" or "nearly," as in the following sentences:

The cost of production is in the vicinity of 50 percent of the selling price.
Its population is in the neighborhood of 1,500.

Watershed, divide

"Watershed" primarily means the divide separating one drainage basin from another and in the past was generally used with that meaning. However, over the years use of the term to signify drainage basin or catchment area has come to predominate. Therefore, use of "watershed" for the area drained is permitted, although "drainage basin" is preferred; "drainage divide" or just "divide" is used for the boundary between one drainage area and another.

While

Many writers use "while" as a conjunction instead of "though," "although," "whereas," "but," or "and," as well as in its primary sense as an adverb of time.

Some writers learned in their schooldays that "though" and "yet" are proper correlative conjunctions, but in their writings they correlate "while" and "yet": "While this is the usual arrangement, yet * * *"; "While coal and oil command high prices, yet * * *." The "while" in the last sentence is also misleading, for at first it seems to be an adverb of time.

Some humorous comparisons are afforded by the following examples:

While this work is in progress it is not completed. (Before this work is done it is not done.)

Martin and Stanton devoted about 2 weeks to the general geologic problems while Stone spent about a month in studying the coal measures. (Time seems to have passed more rapidly with Stone than with Martin and Stanton; or a month's work in the coal measures may equal 2 weeks' work elsewhere; or perhaps Stanton's 2 weeks and Martin's 2 weeks should be added to equal Stone's month. It would be better to insert a comma after the first clause and use "and" instead of "while.")

In Texas the men were in the field for an average of more than 20 days, while in Maryland they were in the field for 155 days. (The days must have been long in Texas.)

The mining on claim 3 is being done in winter, while that on claim 4 is being done in summer. (Contemporaneity of the seasons.)

The greatest geosynclinal accumulations in the Paleozoic were just east of the batholith, while comparable thicknesses of Mesozoic beds were deposited in a trough 150 miles or so farther east. (Telescoping of geologic time.)

In the following sentences "while" should be replaced as indicated:

While [Although] windmills are economical, they are subject to destruction by severe storms, *while* [and] in calm weather they produce nothing.

In several of the Cretaceous formations they are among the most valuable diagnostic fossils, *while* [and] at a few localities they occur in great numbers.

Much uncertainty has existed as to the specific and generic relations of these forms, *while* [and as to] their geologic distribution *has been much in doubt.*

At some places this zone is 4 feet wide[;] *while* at others it narrows to 10 inches.

Quartz and calcite were locally deposited with the copper[;] *while* the zeolites were later than the copper.

"While" has been misused so much for "though" and other words that some authors avoid using it altogether. It is used properly as an adverb of time in the sentence "While the sea was shallow, sand was being deposited."

With

"With" is much misused, especially for "and" as in the sentences quoted below:

The vein has a northeast strike *with* [and] a vertical dip.

The rocks have been indurated[,] *and* tilted, *with some slight folding* [and slightly folded].

The ores in the limestone consist of crystalline aggregates of magnetite *with* [and] small amounts of other *associated components* [minerals].

At San Marcial the average rainfall is 4.84 inches *with a* [and the] minimum *of* [is] 1.17 inches.

"With" is used in the sense of "but" and a verb in the following sentences:

The rocks are mostly gray slate *with* [but include] some graywacke.

The water is very clear *with* [but has] a faint bluish tinge.

The surface of the bedrock is fairly even *with* [but contains] depressions representing temporary channels of the shifting creek.

"With" is sometimes used in place of a verb, as in the sentence "The rock is even grained, finely laminated, and well bedded and *with* [exhibits] clearly defined horizontal jointing."

"With" is superfluous in "The term 'mica' denotes a group of minerals having similar physical properties and *with* related chemical composition."

The sentence "The adjacent lands and tributary streams are grass

covered with scattered oaks" raises problems regarding plant cover that may baffle even the patient reader. Other examples of the misuse of "with" follow:

A fine-grained [greenish] rock *which is greenish with blotches of a* [blotched with] bright pink *color* * * *.

The conglomerate pebbles are well rounded *with a very loose cement* [and loosely cemented].

The top of the mountain is flat with a smooth descent on the south and west. (Write, "The mountain has a flat top and smooth slopes on the south and west.")

He discusses the geology of the county *with descriptions of* [and describes] 19 mining districts.

WORDS OF SIMILAR MEANING DIFFERENTIATED

Different uses of some words of similar meaning found in scientific writings are given and discussed here. Usage, good or bad, in the English language is determined elsewhere than in the dictionaries, and by persons other than the "authorities"—that is, it is determined by general acceptance rather than by the intention of individual writers.

However, the writer of scientific reports needs to be careful in his use of words, and he should be reasonably conservative in differentiating between words of similar meaning. Of some words there is little doubt about the precise meaning. Of others, the shades of meaning may be hard to distinguish. Many books have been written on this subject; among them the following may be of the most help: "Webster's New International Dictionary," second edition; "Webster's Dictionary of Synonyms"; H. W. Fowler's "A Dictionary of Modern English Usage" and its Americanized version, Margaret Nicholson's "A Dictionary of American-English Usage"; Eric Partridge's "Usage and Abusage—A Guide to Good English"; and Sir Ernest Gowers' "Plain Words: Their ABC."

The work that will be most readily at hand to Survey authors is Webster's dictionary, and for most words it is all that is needed. It has the advantage of recording American usage; authors should keep in mind that we are concerned with American usage and that for many words there is wide variance between American and English usage and spelling. It is also the guide for spelling prescribed by the Government Printing Office for Government reports.

Ability, capacity

"Ability" refers to being able or having power to do something. "Capacity" denotes power to receive, contain, hold, or absorb; extent of room or space. In "Moreover, the *capacity* [ability] of a channel to carry sediment of one size is at least partly independent of its *capacity* [ability] to carry another size," the problem is one of power to do, and "ability" is the right word. "The tank has a large capacity" or "The

aquifer has a large capacity to store water from precipitation" is correct.

Apparent, evident, obvious

"Obvious" means easily seen, in the sense of discovered. "Evident" denotes the existence of visible signs, all pointing to one conclusion. "Apparent" goes one step beyond "evident" and implies visible signs and some reasoning, as in "The absurdity of their contention is apparent to one who knows the effects produced by the same causes in the past."

Appears, seems

"Appears" in its primary sense means to come into view, as in "As one travels westward the mountain appears over the horizon in the southwest." "Appears" means also to apprehend and therefore approximates "seems" where "seems" suggests evidence that satisfies the judgment of the writer, as in "It seems clear that the rock was originally a sandstone." "Seems" may suggest something in opposition to fact, however, as in "The rock seems to be gray, but on close inspection it is seen to be buff." If it is desired to maintain a distinction between "appears" and "seems," the first definition for each should be followed.

Appropriate, suitable

That which is "suitable" meets the demands made of it and is not incongruous. "Appropriate" goes beyond "suitable" to denote what is so very fit or suitable that it is the property of the person or thing associated with it.

Apt, liable, likely

"Apt" implies fitness, "likely" stresses probability, and "liable" implies unpleasant consequences; but not all correct usages of these three words can be stated so simply. "Apt" also denotes bent or predisposition, in which sense it refers to past and present more than to the future. "Apt" and "likely" are often interchanged, as in "Damage is apt (or likely) to be done." "Liable" means also responsible or answerable to authority, or subject to forces beyond one's control.

Around, about, approximate

"Around" is incorrect for "about" in the sense of nearly or approximately. "Approximate" in the sense of approach refers to a quantity that approaches, but does not necessarily equal, a given quantity. "Approximately" and "about" imply a reasonable degree of accuracy. "About" is preferable, especially where space is at a premium; "approximately" is preferable where fairly exact figures are given.

Assume, presume, postulate

In the sense of suppose, "presume," which is roughly similar to "assume," expresses what the presumer believes until it is proved wrong, and the presumption should be based on experience, theory, or logic. "Assume" perhaps should mean to take for granted with less reason for doing so than to take that which is presumed; it emphasizes the arbitrary acceptance of something as true. "Postulate," in the sense of suppose, means to assume, especially as a basis for argument. Webster says, "One can assume * * * at any point in a course of reasoning, but one postulates something or lays down a proposition as a postulate only as the groundwork for a single argument, or for a chain of reasoning, or for a system of thought." In considering "postulate," scientific writers might ponder whether they actually mean that word, or perhaps "infer" or "conjecture."

Balance, remainder, rest

"Balance" is properly used to denote the difference between two amounts when their comparison is in one's mind. Without this idea of comparison, "rest" or "remainder" is the better word. "Rest" is preferred to "remainder" when there is no implication of subtraction, depletion, or deduction. If such an implication does exist, as in "Two faults trend northeast, but the rest trend east," either word is correct. "Remainder" seems preferable in describing laboratory analyses even when that which remains is not thought of in terms of amount, weight, or the like, but "rest" has the virtue of being shorter.

Beside, besides

"Beside" means by the side of. "Besides" means in addition to or other than. Some scientific writers prefer "in addition to" to "besides" where an adding to, or union with, something is meant; "besides" may not be as clear here because it may be taken to mean "other than" in the sense of except.

Between, among

Strictly speaking, "between" requires two objects; "among," more than two. However, current usage permits use of "between" with more than two objects, as when each item is considered in relation to each of the others.

Calculate, compute, determine, estimate

"Calculate" and "compute" are both akin to "reckon" and mean to determine by mathematical processes. "Calculate" seems to be preferred when the process is intricate and the result arrived at is problematical, as the distance from the earth to the sun. "Compute" implies that the material for reckoning is known data or actual figures.

"Estimate" may imply calculation or computation, but it implies also use of one's judgment or experience and a result that is not necessarily exact. "Determine" in the foregoing sense means to find out exactly, to ascertain, or to fix precisely. It should not be used loosely for "compute," "calculate," or "identify." The last should be used in identifications of fossils, minerals, and rocks. (See "Identify, determine," p. 180.)

Can and could, may and might

The words listed may be either auxiliary or principal verbs of indicative or subjunctive mood. Usage is tending to make them subjunctive or coloring verbs which themselves do not express time. Examples best illustrate the principles of use of the words.

You may take your annual leave whenever you wish (permission).
You cannot take your annual leave now (denying permission; "can" is commonly used, but "may" is historically the older word in this sense).
A stream in quasi-equilibrium can form a braided channel (ability).
I can do it (statement of ability to do).
The mineral may be bertrandite (present possibility due to circumstances).
The mineral can be bertrandite (like "may" but stronger).
The mineral might be bertrandite (like "may" but weaker).
Your map may have been mislaid (past possibility).
Your map might have been mislaid (faint past possibility).
We can expect snow in the San Juans in September (stronger possibility than "may").
That cannot be zeunerite ("may" would be much weaker).

"Could" is the past tense form of "can," as in "I would have denied it if I could" ("if I had been able"). "Could" is used less often than "may," "can," and "might" to express probability.

Center, middle, midst

"Center" is a point that is, or closely approximates, the true center. "Middle" denotes a space rather than a point, and may be the part of an object surrounding the "center"; also, it may refer to the central part of a linear feature. "Midst" is very much like "middle" except that it often implies a number or group of surrounding or enveloping objects or persons.

Characteristic, distinctive, typical

"Typical," which is opposed to "individual," denotes that the thing or person markedly shows the characters peculiar to the type, class, species, or group to which it belongs. The "characteristic" quality of something is the one that distinguishes and identifies that thing. "Distinctive" denotes an individuality that sets something apart from its type or group.

Common to, common in

A fossil may be "common in" (found in considerable number in) a formation; five spiral ribs may be "common to" certain genera of gastropods.

Commonly, generally, occasionally, usually

In the sense of this comparison "commonly" refers to something that occurs frequently, and "generally" refers to something that is extensive though not universal. "Occasionally" has a connotation of time. Also, it denotes infrequent occurrence and irregularity or nonconformity to a law that might govern occurrence or appearance. "Usually" perhaps should be reserved for that which is customary or habitual, or for what the living do with some degree of regularity. (See also "Sporadically," p. 182–183.)

Compose, consist, comprise, constitute

In the sense of this comparison, "compose" requires a plural subject, as in "The Pleistocene and Recent epochs compose the Quaternary period." The subjects go together to form or make up the thing expressed by the object. "Consist of" is synonymous with the passive form of "compose," as in "The rock is composed of (or consists of) plagioclase, orthoclase, and accessory hornblende and biotite." "Comprise," which is similar to "include," should have as its subject the whole that is made up of the parts that are its object, as in "The Quaternary period comprises the Pleistocene and Recent epochs." "Constitute" is similar to "compose," as in "Feldspar, quartz, and dark accessory minerals constitute (or compose) the typical granite."

Contains, has, holds

"Contains" means to have within, and "holds" means to have the capacity (or ability) to contain or retain. "Has" implies possession more than does "contains."

Continual, continuous

"Continual" refers only to time, and it means always going on or recurring at short intervals and literally or figuratively never ending. "Continuous" refers to both time and space, and it means that there is no break between the beginning and the end, or between one limit and the other.

Continued, extended

In the sense most frequently meant in Survey writing, "continued" suggests an unbroken course or the lack of an end to the process it refers to, as in "The stream has continued to flow ever since." "Ex-

tended" means lengthened in space or time and figuratively increased in scope, as in "Mineralization extended into the country rock."

Data, facts, information

In scientific writing, "data" is used perhaps most frequently in a mathematical sense and is defined by Webster as any magnitudes, figures, or relations supposed to be given, drawn, or known in a mathematical investigation, from which other magnitudes, figures, or relations are to be deduced. In meaning it is akin to "give." In another sense it can mean "material serving as a basis for discussion and inference." "Fact" basically hints that something has been proved by experience. "Data" may be numbers arrived at by measurement or extrapolation and pointing to a fact. "Information" may be synonymous with "data," but it generally carries the implication of organized data communicated to others or obtained by personal study. Often, however, "information" refers to knowledge gathered from books or persons without verification of its truth. In syntax, the word "data" trips many writers. Though it is used widely in the singular, strictly it is a plural term and is so indicated by the Government Printing Office "Style Manual" and used by the Survey.

Datum

Among the uses of the term "datum" is its application to (a) the top or bottom of a bed of rock on which structure contours are drawn, (b) a geologic horizon used as a reference plane for the position of rock strata or for the comparative measurement of the thickness of rock strata, and (c) an assumed or fixed elevation of a specific point or level surface, usually mean sea level, from which elevations (altitudes) are measured. The plural form is datums.

Doubtless, probably

"Doubtless," strictly speaking, means "without doubt," but it is commonly used to mean something a little stronger than "probably." This common use is not incorrect but lacks precision.

Essentially

"Essentially" means necessarily or indispensably. As used in scientific writing in the sense of principally, chiefly, mainly, virtually, in effect, most of, and almost, "essentially" is a poor choice. "Most of the formation is limestone" is preferable to "The formation is essentially limestone." Generally, in geologic writing, use of the adjective form in such expressions as "essential minerals"—meaning minerals that are invariably present in a particular rock, as quartz and orthoclase are in granite—is safe from error.

Exhibit, display, show, expose

"Show" implies enabling someone to see or to look at something, or having a feature that can be seen, as in "The rock shows signs of weathering." "Exhibit" and "display" imply a putting forward conspicuously or openly, or a putting in position where one may see to advantage. "Expose" implies a bringing from concealment.

Factor, feature, condition

In scientific writing, "factor" is used frequently in a mathematical sense. It is used also to mean something that is active or is a contributory element in causation—a maker or doer. A "feature" results from a forming or making and is not an active agent in the doing, as in "Hoodoos are a feature of the terrain in the Badlands." "Condition," says Webster, means "a circumstance essential to the appearance or occurrence of something else; a prerequisite." Among other senses, "condition" may mean state of being or existence.

Fewer, less, lesser, smaller

"Fewer" and "less" are frequently confused. "Fewer" is the comparative form of "few" and denotes a difference in number of units or individuals; it must modify a plural noun, as in "This rock has fewer crystals of pyrite than that one." "Less" means not so much in amount, degree, weight, value, and such, as in "This water contains less sodium than that one"; less than a bushel, but fewer than three apples. "Lesser" is the comparative form of "less" and means not so great, important, or significant as the thing compared: the greater amount, the lesser amount. "Smaller" refers to size or quantity.

Find, locate

"To find" is to come upon something lost, hidden, or obscure. "To locate," roughly in the sense of to find, means to come upon the position of, and it emphasizes position or place, not the object sought. One would locate a noise by finding the source of it. "To locate" a well or mining claim, meaning to fix or establish its location, is chiefly an American usage but a well-established one. After the well or claim has been located, it is generally unnecessary to use located (or situated) in referring to its position.

The well is 2 miles east of Barstow.
The mine is in this eastward-trending fault zone.

Grows, becomes

"Grows" is used undesirably for "becomes" in the sentence "The gravel is coarse near Portsmouth but *grows* [becomes] finer grained downstream." Obviously the particles do not "grow" by attrition.

Similarly, "grows" is wrongly used in writing of processes and changes of condition where growth is not involved.

Identify, determine, ascertain

"Identify" means to consider to be the same in any relation. For example, one identifies a fossil as of a certain species. "Determine" in the same sense is very much like "ascertain" but should imply greater emphasis or intent to establish the truth or facts than does "ascertain." "Determination" often is used unjustifiably for the obtaining of simple data, measurements, or counts, such as the number of radial ribs in a given species of gastropod; however, "determination" can correctly denote the taxonomic classification of a fossil, or a quantity ascertained in a chemical analysis, as "a determination of the chloride content."

Imply, infer, deduce, conclude

"Imply" and "infer" are easily distinguished but often confused. "Imply" means to express indirectly, suggest, hint. "Infer" means to reach a conclusion from hints, evidence, and facts, by reasoning. In another sense, "infer," "deduce," and "conclude" may be compared and differentiated. Strictly, "deduce" means to derive an inference from a principle; popularly, "deduce" is like "infer" but more positive. "Conclude" means to bring a process of reasoning to an end or to close an argument as the necessary consequence of evidence and interpretation.

In, within

"In" denotes place, position, location; also it denotes the end or limit of a given time, distance, quantity, or degree, as in "He will return in (at the end of) a week." "Within" denotes some time short of the end, as in "He will return within (in less than) a week"; also, a distance short of a given distance, or a quantity or degree short of a given one.

Notable, noted, noteworthy, notorious

The following differentiations are the common ones: "Notable" denotes worth, as "a notable performance"; "noted" means well and widely known, as in "He is a noted petrologist"; and "noteworthy" in its basic sense means worthy of observation or remark. "Notorious" generally means famous in a bad way, as a "notorious criminal."

Number, quantity, amount

According to Webster, "amount" implies the combination of sums, weights, or measures that form a whole, as in "the amount of ore mined in one year." "Number" is used for an aggregate of persons or things,

to which (except for things in bulk or mass) "amount" should not be applied. "Quantity" is applied generally to the measure of a bulk or mass, but in scientific usage it is applied to anything, according to Webster, "measurable in extent, duration, volume, magnitude, intensity, or value."

Opinion, judgment

An "opinion" is a conclusion based on information just short of all facts necessary for certainty, and it suggests a highly personal element in the conclusion reached. It implies more information and reasoning than does "feeling" used similarly. "Judgment" implies critical and competent testing of premises or of conflicting evidence and the fitness of the conclusion for affirmation. In legal usage "opinion" and "judgment" have meanings somewhat different from the above, but the legal meanings generally are not used in Survey reports.

Or so, or more

The expression "or so" used after a number or quantity means approximately that number, a little more, or a little less. The expression "or more" used after a quantity or number means a greater quantity, amount, or number or that which exceeds or surpasses what it is compared with. "Or more" after a statement of range destroys the supposed upper limit of the range.

Permeable, impermeable

"Permeable" and "impermeable" are more commonly used than "pervious" and "impervious."

Practical, practicable

Roughly, the "practicable" is the possible; the "practical" is the workable, as in "The scintillation counter, which once was thought not practicable by some, has become practical."

Produce, yield

"Produce" generally means to bring forth by natural or human agency, and "yield" to give out either from within confines or from within one's power of production. In reference to wells, some use the two terms interchangeably, but others may distinguish between "yield," meaning maximum potential, and "production," meaning regulated flow or quantity pumped. Some writers insist on "production from the mine was 100 tons" rather than "the mine produced 100 tons." Differentiation should be made when necessary between "yield" and "contain," as in the following: "The ore contains 0.5 percent iridium" but "The ore yields 0.4 percent iridium" (possibly not all the iridium is extracted or recovered).

446304 O—58——13

Prominent, conspicuous

"Prominent" generally should be restricted to its root meaning of jutting out or projecting above a level or beyond a surface. "Conspicuous" denotes something the eye (or the mind) cannot miss. Rock colors or bedding planes might be conspicuous; a volcanic cone might be prominent as well as conspicuous.

Provided, providing

Used as a conjunction, "provided" introduces a clause of condition upon which the main statement is based, as in "Provided (or "Provided that") his data are correct, your theory is invalid." "Providing" is sometimes used as a conjunction in the same way, but "provided" is the preferred form. "If" can always be substituted for either word.

Rare, scarce

"Rare" applies to things that are seldom present; "scarce" applies to ordinary things not present in abundance locally, or at the moment. In one formation a genus of fossil might be present everywhere, but in another formation the genus might be scarce in some places and common in others.

Say, state, claim, assert, report

"Say" fundamentally means to express in words, either orally or in writing. "State" is stronger than "say" and is appropriate when the context is formal. "Assert" means to state positively. "Claim" means to demand as due, as in "He claims to be the heir"; it is misused for "assert" and "maintain." "Report" in scientific writing is a telling or recounting, generally of a study or investigation.

Something, somewhat

"Something" is the opposite of nothing. "Somewhat" as an adverb means to some extent or partly.

Sparingly, sparse

The adverb "sparingly" is used in some sentences instead of the adjective "sparse." "Sparingly" means, among other things, careful in the use of one's money or resources, provident, reticent, scanty. "Sparingly" stresses abstention or restraint. "Sparse" means a few scattered elements; having spaces between the component parts; scanty; not thickly grown or settled; thinly scattered.

Sporadically, occasionally, intermittently

"Sporadically" implies lack of continuity; rare or isolated existence. "Occasionally" denotes infrequency, or now and again, as well as "on occasion." "Sporadically" primarily refers to space; "occasionally,"

primarily to time and space. "Intermittently" means disappearing or being absent from time to time but always returning. Unlike "recurrent," which stresses repetition, "intermittent" stresses a break in continuity.

Succession, sequence, series

"Succession," "sequence," and "series," as compared here, denote a number of things that come together in some order or by some plan. "Succession," the most general term, denotes any kinds of things that follow one another in order of time or place. "Sequence" implies a closer association among the things concerned or a fixed order of recurrence, as the sequence of the seasons. "Series" denotes a succession of things that have similar nature or that stand to one another in similar relations. Information on the use of "series" and "sequence" in stratigraphic nomenclature is given on pages 79–91.

Typically, generally, usually, mostly

"Typically" is the opposite of "distinctively" and implies that what is typical is hard to differentiate from others of its type, class, or the like. "Generally," from the same stem as "generic," refers to all or nearly all of a type, class, group, or other loosely associated things or persons; it may refer to time or extent. "Usually," implying habit or custom, should not be confused with "generally." "Mostly" has no or little reference to the typical or general, but means chiefly or for the most part, in the sense of weight, measure, number, space, and such.

ABSTRACT TERMS

The use of abstract terms for concrete terms that are easily understood is one of the commonest faults in scientific writing. It not only multiplies words but befogs meanings and imposes unnecessary burdens on the reader. The author should ask himself, after he has written an abstract term, "What do I mean by this term? What is the concrete thing about which I am writing?" He can generally supply the concrete term without trouble, and he may discover that the abstract term is mere verbiage.

Along these lines

"Along these lines" or "along this line" is trite, unprecise, or unclear, and it usurps the place of better phrases. The following sentences can be improved easily:

A large part of the area is irrigable, but *activities along this line have up to the present time been* [irrigation at present is] confined mainly to the stream valleys.

Investigations along petrographic lines [Petrographic investigations] * * *.

These analyses were *conducted along the same lines* [made in the same way].

In referring of a certain mineral a geologist writes, "Its application along all these lines is expanding," meaning "Its use for all these purposes is increasing."

Cases, instances

The correct use of "cases" and "instances" is unfamiliar to many scientists and engineers, who write sentences like these—

The lowlands in some *cases* [places] contain lakes, the most conspicuous *instances* being Crystal, Glen, and Portage Lakes.

In a few *instances* [places], as at Clement Point * * *.

One such *case* [eruption] is definitely known to have formed a cinder and ash cone over 200 feet high. (So elusive a thing as a case cannot form so substantial a thing as a cinder cone.)

Specimens in some *cases* [specimens] show veins of calcite.

The enrichment observed in the *case of the* copper veins * * *.

In most of these *cases it has been found that the* coal beds have certain peculiarities by which they can be recognized.

In the case of the solutions affecting the monzonite *they* were evidently rich in potash.

In most cases metamorphism [usually] is accompanied by chemical changes.

In many *cases* [of] these well records have been carelessly kept.

This is the only *instance* [magnetite mine] in the quadrangle *of a magnetite mine* that is wholly in the limestone.

In one *case* [specimen] of a fresh rock, small prisms of augite are fairly abundant, but *in the majority of cases* [generally] the ferromagnesian silicates are represented only by chlorite.

In every *case an* alteration product should be identified with extreme care.

In each *instance the* supposed *fact* [identification] should be scrupulously verified.

If younger sediments were deposited upon the Perry formation *as was the case* [in this region, as they were] in parts of New Brunswick, [they have been removed by] erosion *has removed all of them.*

There are several cases, however, where wells * * * finally failed to yield either oil or water. In such cases the casing has been pulled and the hole filled with cement. (Write, "Several wells, however, finally failed * * *. The casing has been pulled from such wells and the hole filled with cement.")

The sentences below contain undesirable or superfluous "cases" or "instances."

In the case of [When] Indian lands *that* are to be thrown open to settlement, it is desirable to know beforehand what parts of the lands contain valuable mineral deposits.

One of the most interesting *cases illustrated an instance of what seemed to be a* [and] puzzling [features of the deposit was that in one place the bedding seemed to be] *case of* vertical *bedding.*

The following sentences are examples of the proper use of "case":

Take an extra pair of shoes with you in case of need.

Of strategic importance is the fact that plants in the coastal areas of the United States would be somewhat more vulnerable than inland plants to possible air or sea attack in case of war.

Character, conditions, purposes

Some writers intrude such words as "character," "conditions," and "purposes" into sentences in which they are superfluous or even absurd.

The surface is *of a* very uneven *character.*

With proper drainage *conditions* the land could be made suitable for farming *purposes.*

The flow of the stream was obstructed by ice *conditions.* (However, in surface-water investigations, the term "ice conditions" has a specific meaning, as in "The accuracy of the measurements was lowered by ice conditions.")

Most of this petroleum is used for fuel *purposes.*

Under [In] base-leveled *conditions* [regions] underground circulation generally is sluggish.

The river here *loses its split-up character and* [is not split up but] flows in a single channel.

The *soft nature* [softness] of the beds * * *.

The mesas are arid, and *because of their disconnected character there is* [as they are disconnected they afford] no means of storing water for irrigation *purposes.*

"Under extremely shallow-water conditions" generally means "in very shallow water"; "tuffs of an andesitic character" probably means "andesitic tuffs"; and "public roads of fairly good character" means "fairly good public roads."

REPETITION

UNDESIRABLE REPETITION

A writer may repeat, without offense, certain minor words such as "a," "and," "the," and "of." If words like "data," "occurs," and "important," or especially, if a more unusual word is repeated in a single sentence or paragraph, the repetition at once diverts the reader's attention from the subject matter.

Avoid using the same word to convey different meanings in a sentence. One author wrote, "These do not resemble the diatomaceous remains found in the chalky shale, and their character remains indeterminate."

PROPER REPETITION

Repetition is desirable when it clarifies or emphasizes a point. Synonyms are occasionally useful for relieving monotony, but some writers use a substitute for a term that ought to be repeated and they thereby divert the reader's attention from the main thought. They say, for example, "outside areas" in one clause and "extraneous regions" for the same idea in the next.

This species is based upon a single incomplete specimen; a second *example* [specimen] showing similar sculpture * * *.

On the west side of the mountain * * * but on the east side of the *same eminence* [mountain] * * *.

Water supplies which in more humid regions are wholly or almost *entirely* [wholly] neglected here become of great importance.

Most of the phenomena are due to lack of water rather than to the presence of *that agent* [water].

This sandstone is well exposed at Whiskey Gap, where it forms the narrowest part of *this topographic feature* [the gap].

To understand the sentence "Andesine and augite are the essential minerals and usually are found in the proportion of 3 of the plagioclase to 1 of the pyroxene," the reader must remember that andesine is a plagioclase and augite is a pyroxene. The variation in terms was unnecessary, anyhow, because "the proportion of 3 to 1" would have been perfectly clear. The writer in his next sentence used neither "andesine" nor "plagioclase" but "feldspar"—3 terms used for the same thing in 2 sentences.

The phrase "the same" should not be used to represent a preceding noun, as in the following sentences:

Neither a mere report on the area nor a monograph *on the same* * * *.

In appearance it resembles epidote *and is often mistaken for the same* [, for which it is often mistaken].

The writer of the following sentence avoided what he thought would be tautology not by the use of a synonym but by too much condensation:

The formation is of fresh-water origin in the west and *brackish* [of brackish-water origin] in the east.

SHORT WORDS VERSUS LONG WORDS

A long word is not objectionable simply because of its length. The word should be chosen that best expresses the meaning, but if a short word is available it is generally to be preferred. An author should consider, for example, whether "numerous" cannot be replaced by "many"; "approximately" by "about"; and "during" by "in." (See also "Many, numerous," p. 163, and "Around, about, approximate," p. 174.) Moreover, the repetition of a short word does not divert the reader's attention so much as that of a long word.

PREPOSITIONAL IDIOMS

The current uses of a few common prepositional idioms are given below. Others may be found in dictionaries and textbooks.

Compare: one thing **with** another, similar thing; one thing **to** another, different thing.

Conform: **to** practice, **to** a design; comformable **to,** in conformity **with.**

Consist: **in** performing an act, or **in** a definition or statement of identity; **of** quartz and calcite.

Contrast (verb): one thing **with** another.

Contrast (noun): **between** things; present a contrast **to** a person or thing; one person or thing placed in contrast **with** another.

Correspond: correspond **to** things; correspond **with** (write letters **to**) persons.

Differ: pyrite differs **from** gold; he differs **with** that opinion.

Different **from** (not different **than**).

Essential: essentials **of** geology; essential **to** success; the first essential **in** preparing a specimen.
Identical: one thing **with** another (not **to** another).
In search **of**; the search **for**.
Independent **of** (not **from**).
Necessary: **for** a trip; **to** advancement.
Overlain **by** (not **with**).

EUPHONY

Euphony—a "harmonious succession of words"—is as desirable in scientific reports as in other writing; lack of euphony may divert the reader's attention from the substance to the style of a paper. Examples of alliteration, which makes writing conspicuous and reading difficult, are given below.

Crustal movements crushed and crumpled the Cambrian rocks.
The interval that intervened.
A much larger and longer lived lake.
Not uncommonly conglomeratic.
Further fissuring, faulting, and fracturing.
Conglomerates with well-waterworn polygonous pebbles.
A somewhat similar series of sediments.
Analyses in uniform form.
As erosion proceeded the ore became shattered and scattered through the clay.
Inasmuch as much the same characteristics.
Around these mountains lie low-lying lands.

COLLOQUIALISMS

Survey report writing is formal writing, and the colloquial should be avoided unless a colloquialism effectively serves a special purpose. Colloquialisms are not formal standard English and they vary from group to group and family to family, but there is also a large body of colloquial expressions common to all.

LATIN AND OTHER FOREIGN WORDS AND PHRASES

Foreign words and phrases are used unnecessarily by many writers where English terms would be suitable. Among these words and phrases are "videlicet" (viz), "id est" (i. e.), "exempli gratia" (e. g.), "débouchure," "in situ," "brochure." The following sentences can be improved by being rewritten entirely in English:

These oxides were carried away in toto.
Chalcocite enrichment is practically nil.
The surface bore prima facie evidence of freedom from erosion.
This formation was laid down in local troughs *the sag of which proceeded pari passu with the deposition of the sediments* [that sank as fast as the sediments were deposited].
The compacting of the sandstone seems to have *proceeded pari passu* [kept pace] with the leveling.

"Per contra," "in vivo," "in loco," and other Latin phrases are in favor with a few writers, some of whose manuscripts contain false

plurals like "lamina," "lamella," "foliae," and "septae" (for "laminae," "lamellae," "folia," and "septa").

Even the generally meaningless "etc." and "et al." can profitably be replaced in many sentences by significant English, as in "The gangue consists of quartz, *etc.* [and other minerals]"; "Damour, Hersch, *et al.* [and others]." Remember, also, that "etc." applies to things only and not to persons. In bibliographies and other listings of names use "and others," not "et al."

The term "etc." is not only superfluous but improper in the sentences quoted below, where it is used after "for example" and "such as."

Deposits of this occur in several mines—for example, the Telegraph, Commercial, [and] Old Jordan, *etc.*

The solution contained mineralizers, such as fluorine, [and] boron, *etc.*

The glacial features that give variety to the surface, such as moraines, kames, [and] eskers, *etc.*, are described.

SUPERFLUOUS WORDS

Some writers use too many words. Needless repetition and the use of words that are structurally unnecessary detract from clearness and emphasis. Many long, involved sentences, like the following, can be reduced in length to form simple, unambiguous statements which are easily and clearly understood:

Owing, therefore, to this probably limited thickness and the very fine grained texture of the rocks, these strata would yield very little ground water. (Write, "These thin beds of fine-grained rocks would yield very little ground water.")

Since that time there have been numerous taxonomic changes in the generic assignment of several of the species, and there are now 53 species which are considered valid members of the genus as interpreted by the writer (37 words). (Write, "Since then, taxonomic changes have raised to 53 the number of species that the present writer considers valid members of the genus"—22 words.)

Furthermore, *the obscuring effect of* the terrace and loess deposits *prevents detection of* [obscure] the structure in the underlying Eocene.

Superfluous and improper words italicized in the following examples should be omitted:

Throughout *the whole of* the Mesozoic era.
Throughout the *entire* area.
A series of parallel ridges resembling in *their* form * * *.
They are *both* alike.
There can be no doubt *but* that it is Cretaceous.
The Survey has not *as* yet done any work in this region.
The conditions were favorable for landslides *to occur.*
Equally *as* well.
Most of the intrusive masses are *of* large *size.*
The rock is dark green *in color.*
An innumerable *number of* tiny veins.
Bilateral asymmetry.
Contemporaneous *in age.*
A report giving the results of the work is in *progress of* preparation.

No *side* streams enter Red River from the north.

At its base the formation lies on a remarkably even surface of granite.

About a mile *in a* northwest*erly direction from* [of] Fort Bayard.

Lenticular *in character.*

Grass Creek almost bisects the basin *into two parts.*

In every respect except size the Ashe County deposits are exactly like *those exhibited by* the Cranberry deposit.

Minerals formed after the rock in which they are found *had preexisted.*

The ores are of igneous origin *originally.*

Lake Superior is the largest *of any* lake in this region.

It is noteworthy that in this group of mines, especially those on the west side, *that* galena is the most conspicuous mineral of the ore.

Introductory phrases like those below, perhaps intended to "break it gently" to the reader, can often be omitted or else be replaced by fewer words.

As already stated * * *.

It may be said that * * *.

It might be stated that * * *.

Concerning this matter it may be borne in mind that * * *.

In this connection the statement may be made that * * *.

With respect to the occurrence of these ores it has been found that * * *.

It is possible that the ore *is* [may be] primary.

There can be little doubt that this fissure is [almost certainly] the prolongation of a fault *of the same character as the one* [like the one] already described.

All of

The word "of" in the phrase "all of" is generally superfluous. According to the "Standard Dictionary," "all of" as a popular idiom is used to emphasize the totality of that which is referred to, as "How many of these men did you see?" "I saw all of them." The best literary usage omits the "of" as needless, preferring "I saw them all."

The usage just stated represents the judgment of many literary critics, a judgment based on the assumption that in phrases like "some of," "many of," "one of" the word "of" is a partitive—that is, a term implying partition or denoting a part—whereas in "all of" no expression of partition is intended. "The whole of" has been criticized on the same ground. A critic writes—

> One may say "the whole staff accompanied the general" or (for emphasis) "the whole of the staff," but it would be better to say "the entire staff" or "all members of the staff," not "all of the members of the staff." "I will take it all" is regarded as better than "I will take all of it."

But "of" after "all" should not be cut out mechanically. In the sentence "Many *but not all* of these fragments are rounded" the italicized words are superfluous, but when they are cut out the "of" should stand.

Found to be, known to be, seen to be

The italicized words in these sentences are superfluous.

These rocks are *found* exposed at many places.
He mentioned the principal lakes *found* in this region.
The St. Peter sandstone is *known to be* jointed in places.
In this region the deposits are *found to be* more sandy.

Some of these phrases, however, are required to complete the sense of a statement, as in the two sentences—

Under the microscope the grains of sand are [seen to be] completely coated with iron.

The rich ore, when examined closely, *consists* [is seen to consist] mainly of fine-grained drusy quartz.

Present, presence

"Present" is a prime favorite with many writers, but "present" and "presence" are generally superfluous, as in the sentences below.

The undulating strata mark one of the many local unconformities *present* in the arkose.

Here cacti are *present in greater abundance* [more abundant] than on the plateau.

In most of its facies quartz is the most abundant mineral *present.*

The metallic minerals *present* in the ores * * *.

The *presence of* open channels that extend downward to caverns may be seen at several places.

The *presence of the* other sulfides of copper were not noted in the district. (Wrong subject but right verb.)

Situated, located

"Situated" and "located" are generally superfluous when used as in the following sentences:

One of the domes is *located* in sec. 31; the other is *located* in secs. 3 and 4.

South of the axis of the principal anticline in sec. 13, there is *situated* a small syncline.

The outcrops are *situated* on the shore *and in* close *proximity* to deep water.

The largest of these outliers is *situated* 2 miles *to the* southeast*ward* of the canyon.

This field is *located* 3 miles north of Bristol.

MULTIPLE COMPOUND ADJECTIVES

The excessive use of multiple adjectives as unit modifiers should be avoided. The examples given below illustrate this fault. Such usage is probably thought to be a space saver, but the effect is to break the continuity of the sentence while the reader is waiting expectantly for the significant noun to arrive.

The alcoholic copper acetate ammonia-solution method.
The west-border-of-Bear-Valley report.
Large 4- to 14-foot-wide bodies of milling ore.
The 425-foot-well water.
A 300,000-kilowatt 70-percent annual-capacity factor basis.

An only 2- to 3-mile-wide schist band.
Primitive moonlike-earth volcanism.
Buff and pale-gray finely and medium-crystalline generally thin-bedded (2 to 18 inches) dense, hard dolomite.

Because the writer of newspaper headlines has scant room in the column for his phrases, we find "1956 Speed Champions," "Heart Disease Victim," "War State Exists" (meaning state of war). Such headings are excusable because of necessary space limitations, but they should not serve as models for scientific writing.

TYPOGRAPHIC STYLE

The publications of the Geological Survey conform in general to the "Style Manual" of the Government Printing Office, of which the 1953 edition is the latest at the time of writing (1957) of this edition of "Suggestions to Authors." It is impractical to cite here all the practices that affect Survey publications, but a few rules regarding questions that are most commonly asked are discussed below. All Survey offices concerned with the preparation and processing of manuscripts should have a copy of the "Style Manual." However, it should be remembered that reports prepared for publication outside the Survey may vary in typographic style from Survey-issued reports, according to the requirements of the publisher.

CAPITALIZATION

Capitalize prepositions or prepositional phrases, such as "van," "von," "de," "d'," "da," "della," "de la," or "di," in personal names if used without the forename, a professional title, or a title of nobility or of courtesy—Van't Hoff, Von Humboldt, De Verneuil, Da Ponte, Della Crusca, Di Stefano. Lowercase such prepositions if they follow the forename, a professional title, or a title of nobility or of courtesy—J. H. van't Hoff, L. G. de Koninck, Fischer de Waldheim, Alcide d'Orbigny, Senhor da Yznaga, G. dal Piaz, P. del Pulgar, G. dell'Acqua, Captain di Cesnola, Constantin von Ettingshausen. In authors' names, follow individual usage, if ascertainable—van Dyke, De Koven, d'Orbigny.

Capitalize the full names of organized bodies and the distinguishing substitutes for such names—North Carolina Geological Survey, Idaho Bureau of Mines and Geology, Connecticut Geological and Natural History Survey, Hayden Survey, Fortieth Parallel Survey, United States Geological Survey (also U. S. Geological Survey), the Survey.

In citations of books, articles, or reports in footnotes, in reference lists, and in bibliographies capitalize the first word, proper nouns, and proper adjectives. (See section on "Citation of publications" p. 105–122.) In the titles of books, articles, or reports quoted in the

text, enclose the titles in quotation marks and capitalize the first word and all important words. Therefore, in a bibliographic citation write, Refractory clay deposits of south-central Colorado; but if this title is quoted in the text write, "Refractory Clay Deposits of South-Central Colorado."

Capitalize the name of a phylum, class, order, family, or genus, but not the name of a species, subspecies, or variety—Arthropoda, Crustacea, Foraminifera, Hypoparia, Agnostidae, *Agnostus*, *Agnostus canadensis*, *Diplotrypa westoni*, *Epigaea repens*, *Quercus palustris*.

Coined paleontological terms derived from proper names are not capitalized—aviculoid, mesodontine, foraminifer.

Do not capitalize derivatives of proper names no longer identified with the names from which they were derived.

babbitt metal	nicol prism, crossed nicols
canada balsam	pitot tube
carlsbad twins	plaster of paris
china clay	portland cement
diesel engine	roman type
harveyized steel	taintor gate
india ink	venturi tube

Do not capitalize a common noun used with a date, number, or letter merely to denote time or sequence or merely for the purpose of reference, record, or temporary convenience. "No." or "number" is used before a figure only where necessary: "Well 3 (not well No. 3) is 85 feet deep." "Of all the analyses, No. 3 (or that of water from well 3) shows the highest fluoride content."

analysis 15	exhibit A	section 10
appendix A	figure 7	species 2
bed 4	level 2	table 19
chapter 3	page 245	test hole 4
class I	plate 23	type F
collection 6812	sample 156	well 162

The following examples will serve to interpret the rules of capitalization for titles of persons and names of units of the Geological Survey as they are used in the texts of reports published by the Survey: Director, Geologic Division, Conservation Division, Water Resources Division, Topographic Division, Mineral Deposits Branch, Ground Water Branch, Quality of Water Branch, Geologic Names Committee, chief geologist, chief hydraulic engineer, chief topographic engineer, chief, party chief, district engineer, district geologist.

SPELLING

"Webster's New International Dictionary," second edition, is the authority adopted by the Government Printing Office for the spelling of words, and it will be followed unless preferred forms are listed in

the "Style Manual" of the Government Printing Office. Generally, if no preferred form is given in the "Style Manual," the form listed first in the dictionary will be used. For the spelling of chemical elements see page 68.

COMPOUNDING

The rules of the Government Printing Office generally will be followed in compounding. Two exceptions are the engineering terms "bench mark" and "base line." They are neither hyphened nor combined in the usage of the Geological Survey except when used as unit modifiers; for example, "bench-mark tablet."

Words combined to form a unit modifier immediately preceding the term modified are generally hyphened.

fire-tested material	thin-bedded limestone
fire-clay deposit	red-bed facies
drought-stricken area	bluish-gray shale
flood-plain deposits	light-green clay
ground-water study	blue-green algae
surface-water study	water-table divide

Write without a hyphen a two-word unit modifier the first element of which is a comparative or superlative.

better drained soil	larger sized grains
highest priced coal	best preserved specimen

Write without a hyphen a two-word unit modifier if the first word is an adverb, as in "often heard phrase" and "carefully prepared report." "Well-defined curve" and "ill-defined curve" are exceptions.

In stratigraphic sections, well logs, and similar lists, unit modifiers follow the noun they modify and are hyphened according to the rules used when they precede the noun.

Sandstone, bluish-gray, coarse-grained, highly shattered
Sandstone, dark-gray, thick-bedded, fine-grained

A chemical term used as a unit modifier is not hyphened: calcium bicarbonate water.

Write without a hyphen a compound predicate adjective the second element of which is a past participle.

The area is drought stricken.	The granite is contact metamorphosed.
The sand is fine grained.	The coal is high priced.

Write without a hyphen a compound predicate adjective or predicate noun the second element of which is a present participle.

The sandstone is ledge forming.
The land is used for cattle raising.

A compound color term is not hyphened unless the term becomes a unit modifier.

The shale is olive green to blue green.
The clays are brick red and chocolate brown.

Color terms are unit modifiers in "olive-green shale" and "brick-red clay."

Combining forms, prefixes, and suffixes do not ordinarily require a hyphen. Some exceptions are noted below.

Use a hyphen with the prefixes "ex," "self," and "quasi."

ex-governor
quasi-academic
self-control (selfsame is exception)

Unless usage demands otherwise (as in "transatlantic"), use a hyphen to join a prefix or combining form to a capitalized word.

un-American
mid-April

Except after the short prefixes "co," "de," "pre," "pro," and "re," which are generally written solid, use a hyphen to avoid doubling a vowel or tripling a consonant, or to prevent mispronunciation or a change of meaning.

anti-inflation
re-treat (treat again)
co-op
un-ionized (not ionized)

Words ending in "like" are not hyphened except to avoid tripling a consonant or when the first element is a proper name.

lifelike
December-like
ball-like

Rules for use of hyphens in rock names, with examples, are given on page 63.

ITALIC

The following are printed in italic: "See" and "See also" in indexes, glossaries, and like matter; names of vessels and aircraft; letter symbols in mathematical equations; and most letter symbols used in physics.

Formal names of genera, species, and subspecies or varieties of plants and animals are ordinarily printed in italic: *Productus*, *Inoceramus fragilis*, *Ostrea congesta* Conrad, *Bulimina elongata subulata*. Names of families and higher groups are printed in roman: Brachiopoda, Mollusca, Foraminifera.

Chemical symbols (even in italic matter) and foreign words are printed in roman.

In general, italic should not be used for emphasis. The matter should be so phrased or arranged that its emphatic part need not be indicated by a mechanical device.

FIGURES

Beginning of a sentence

Numbers at the beginning of a sentence are spelled out. In the sentence "Four thousand eight hundred fifty tons was produced

in 1906, and 5,180 tons in 1907," convenience of comparison requires that both quantities be expressed in figures. The sentence may be rewritten "The production was 4,850 tons in 1906 and 5,180 tons in 1907."

The arrangements of figures shown in the following examples also should be avoided: "The final survey makes the total distance of levels run in 1906 38,307 miles"; "In 1906 464 tons was produced."

Compound modifier

Numbers of less than 100 preceding a unit modifier containing a figure are spelled out: Seventy-nine 6-inch guns (but 120 8-inch boards).

Dates

In Survey reports dates are given in figures: June 20 (not June 20th), the 20th of June, the 2d or 3d (not 2nd or 3rd). In the Department of Defense the day and month are written "20 June," and in material from that department quoted in Survey reports this style should not be changed.

For consecutive years use the contracted forms: 1934–35, 1890–91, 1916–27, 1900–10, 1907–8 (but 1900–1901, 1895–1902). Fiscal years, water years, or meteorological years are written the same way: 1938–57.

A. D. precedes the year; B. C. follows the year: A. D. 937; 254 B. C. A. D. 937 means Anno Domini (in the year of our Lord) 937; 254 B. C. means in the 254th year before Christ.

Decimals

Decimals are expressed in figures. A zero should be supplied before a decimal point if there is no unit (both in text and in footnotes), and zeros should be omitted after a decimal point unless they indicate exact measurement: 0.25 percent, 90 percent silver. (See p. 99–104 for discussion of significant figures.)

Fractions

Fractions that stand alone are spelled out, but where the fraction is joined to a whole number figures are used: one-eighth, three-fourths, 3½, 1¾ (but ½ page to 1¾ pages).

Write half a mile, a quarter of a mile (not a half mile or ½ mile).

Figures are used for fractions in a unit modifier: ½-inch pipe, ⅞-point rise, 0.9-inch spacing.

Indefinite expressions

Indefinite expressions are spelled out: the early seventies, in the eighties (but the 1920's).

Isolated numbers

Isolated numbers of 10 or more are expressed in figures, but isolated numbers of less than 10 are spelled out: 50 localities, five wells, repeated eight times (but 3½ boxes). (See also "Related numerical expressions" below.)

Large numbers

In expressing large numbers, the word "million" or a similar group term is spelled out: 20 million, 3 billion, $5 million (but use figures if other numbers in a series are given in figures: "The appropriation in 1952 was $780,000 and in 1953, $2,000,000").

Numbers separated from unit they describe

Numbers expressing time, money, or measurement separated from their unit descriptions by more than 2 words are spelled out if under 10, as in "Whether five or any other number of years." (But write, "Whether 5 years or any other number.")

Ordinal numbers

Except in formal writing and for day preceding month, figures are used for ordinal numbers beginning with 10th: 82d Congress, 20th century, 38th parallel, 141st meridian.

When ordinal numbers appear in juxtaposition and one of them is 10th or more, figures are used for both: the 1st session of the 82d Congress, the 9th and 10th Congresses.

Quantities and measurements

Age, degree, measurement, money, percentage, proportion, time, and similar matter are expressed in figures: 6 years old, 27°, 45 miles, 9 bushels, 24 pages, 16 by (or ×) 24 inches, $1.54, 17 percent, ratio of 1 to 4, 1:62,500, 10 o'clock, 10 p. m., 4:30 p. m. (but four centuries, three decades).

Related numerical expressions

Figures are used in a group of two or more related numerical expressions, whether or not each number is less than 10: 2 gold mines, 3 silver mines, and 8 copper mines; 3 wells and 11 springs; tested at 4, 28, and 160 days.

A unit of quantity or measurement, always expressed in figures except in round numbers, affects the use of figures for other related or connected numerical expressions: "The 5 mines are 20 miles southwest of the town."

Round numbers

Round numbers are spelled out: almost a thousand dollars, about a hundred miles, about a hundred wells (but 115 wells).

Serial numbers

Figures are used for serial numbers: locality 259, Bulletin 725.

PUNCTUATION

COMPOUND SENTENCES

Use commas before coordinating conjunctions "and," "or," "nor," "but," "for" in a sentence made up of coordinate clauses, unless the clauses are short and closely connected.

The population increased from 10 or 15 to about 200 within 2 or 3 weeks, and tents and frame buildings of all descriptions were hastily erected.

Certain difficulties arose between the contracting parties, and the work was abandoned.

Hops and briars are twined about the shrubs, and flowers grow in profusion.

Skies were clear and temperatures soared.

The slope was steep and the path was rocky.

If the coordinate clauses of a compound sentence are not joined by a connective, use a semicolon.

Recharge from streamflow is about 8,000 acre-feet per year in the entire area; recharge from precipitation is about 17,000 acre-feet.

If a conjunctive adverb is used between coordinate clauses, it is preceded by a semicolon.

The mine was idle for many years; then a new company reopened it.

Explosions had shattered the rocks; hence, structural relations were obscure.

The roads were blocked with snow; consequently, the machinery did not arrive on time.

DATES

Write dates as follows:

June 1955 or June 29, 1955 (not June, 1955, nor June 29th, 1955)
March 6 to April 15, 1955 (not March 6, 1955, to April 15, 1955)
May, June, and July, 1955 (but June and July 1955)

ELEMENTS IN A SERIES

Use a comma after the word preceding "and," "or," or other connective in a series of three or more words or phrases. If, however, the separate members of the series are long or contain commas, use a semicolon between the members.

The deposit consists of clay, sand, and gravel.

The upper coal is 21 inches thick, the parting 12 inches, and the lower coal 18 inches.

The order of deposition was: quartz and pyrite; massive galena, sphalerite, and pyrite; brown carbonates and quartz; and small amounts of all those named, together with fluorite, barite, calcite, and kaolin.

446304 O—58——14

Two or more adjectives modifying a noun or a group of words thought of as a unit should be separated by commas if they are coordinate in application—that is, if all stand in the same relation to the noun or unit that they modify. They should not be separated by commas if the adjectives are not coordinate—that is, if an adjective modifies all the words after it that are considered as a unit. One who is in doubt about the punctuation of a phrase should ask "How much of this phrase is a unit?" In "long, slender, tapering cones," all the adjectives describe shape and thus stand in the same relation to "cones"; therefore they should be separated by commas. No comma should be used between the last modifier and the unit modified.

Examples of coordinate and noncoordinate adjectives follow:

Coordinate	*Noncoordinate*
hard, impermeable subsoil	hard clay subsoil
a brief, interesting account	a brief typewritten account
dark, fertile loam	dark sandy loam
short, swift streams	short tributary streams
long, tedious spell of dry weather	long dry spell
	yellowish-gray clayey sand
	homogeneous earthy material

ESSENTIAL AND NONESSENTIAL MODIFIERS

Essential modifiers are not set off by commas; nonessential modifiers are. In the following examples essential and nonessential modifiers are indicated by quotation marks:

The factors "that influence the formation of huttonite and thorite" are not known. (Essential.)

Uranium forms no silicates "that contain U^{+4}," other than coffinite, but does form a number of uranyl silicates. (Essential.)

Perfect types, "that satisfy all these requirements," are not to be looked for. (Essential but an exception; the clause is coordinated with the adjective belonging to the antecedent.)

The alteration is of two types, "which operate concomitantly." (Nonessential.)

The element thorium, "which was named after Thor, the Scandinavian god of war," was discovered in 1828. (Nonessential.)

The country rock "east of the fault" has been less disturbed by faulting. (Essential.)

The country rock, "both limestone and sandstone," shows no evidence of alteration. (Nonessential.)

These values "added together" suggest that total energy requirements will probably lie in the range of * * *. (Essential.)

INTRODUCTORY WORDS, PHRASES, AND CLAUSES

The usual practice in the use of the comma to set off introductory words, phrases, and clauses from the rest of the sentence is indicated below.

In all, 15 seepage runs were made. (For clearness or emphasis.)

Besides the determinations made for bare-soil tanks, coefficients of drainage and saturation were determined for all odd-numbered tanks. (For clearness if

the phrase or clause is so long that the sentence is not clear without the comma.)

For example, that bed is only 5 feet thick. (If the word, phrase, or clause is parenthetic.)

A comma is used after an introductory phrase that contains an infinitive, a gerund, or a participle, unless such element forms the subject of the sentence:

To operate effectively, they needed better machinery.

To operate effectively is the requirement of a successful organization.

Upon learning the terms, he refused to sell the mine.

Standing above the bolsons, the mountains show a great variety of sedimentary and igneous rocks.

MATTER IN PARENTHESES AND IN BRACKETS

Commas, dashes, or parentheses may be used to set off parenthetic material. Commas are generally used if the material is short and closely related to the rest of the sentence; dashes are preferable if the material is long or if the use of commas to set it off would be confusing; and parentheses are generally used to enclose supplementary or explanatory material. Parentheses should not be placed within parentheses, except where references to years of publication, queried stratigraphic names, and paleontologic usage require them.

If a parenthetic reference to pages or illustrations is made at the end of a sentence, it should be enclosed within the sentence unless "See" is used—"Shown on the map (pl. 6)"; "the accompanying diagram (fig. 6)"; "described below (p. 127)." "The limestone is dolomitized here as at some other places. (See p. 156.)" Use "p.," "pl.," and "fig." for page, plate, and figure in parentheses, as shown above, but write in full outside the parentheses—"This rock is described on page 93."

Brackets are used in quoted matter to indicate a correction, supplied information, an interpolation, a comment, or a caution that an error is reproduced literally.

PLURALS AND POSSESSIVES

The possessive case of a singular or plural noun ending in "s" or with an "s" sound is formed by adding an apostrophe only—Jones', Joneses', princess', princesses', Williams', Cos.' (plural), but Co.'s (singular), conscience' sake.

In compound nouns the "s" is added to the element nearest the object possessed—John White, Jr.'s (no comma) account.

Joint possession is indicated by placing an apostrophe on the last element of a series, but individual or alternative possession requires the use of an apostrophe on each element, as in the following:

soldiers and sailors' home

men's, women's, and children's clothing

editor's or proofreader's opinion

The singular possessive case is used in such general terms as the following: fuller's earth, miner's inch.

The apostrophe is used to indicate the coined plurals of letters, figures, and symbols as follows: 1920's, Btu's, YMCA's, a's, 7's, T's, 2 by 4's.

QUOTED MATTER

Double and single quotation marks are used alternately to indicate quotations within quotations, double marks being used for the original quotation.

The comma and the final period are placed inside the quotation marks. Other punctuation marks are placed inside the quotation marks only if they are a part of the matter quoted.

Quotation marks are used to enclose any matter following the terms "entitled," "the word," "the term," "marked," "endorsed," or "signed," but are not used to enclose expressions following such terms as "known as" and "so-called" unless such expressions are misnomers.

The term "silt" refers to rock particles of a certain size range but is sometimes used incorrectly for all clastic sediment; the so-called bottom load, or bed load, refers to the larger particles which move on or near the bed of the stream and are not continuously in suspension.

ABBREVIATIONS

Abbreviations are used to save space and to avoid distracting the mind of the reader by needless spelling out of repeated words or phrases. However, the amount of space that can be saved in a report by free use of abbreviations is usually so small that custom, the convenience of the reader, and the appearance of the printed page determine their use. In general, few abbreviations are used in the text of reports; many abbreviations may be used in footnotes and tables and in citations of publications. Such material is highly technical and of interest primarily to the specialist who is familiar with the abbreviations used, but other parts of the text should be comprehensible to the nonspecialist. The abbreviations used in citations of publications are discussed on pages 108–122.

The Survey has adopted for preferred use in its reports the "American Standard Abbreviations for Engineering and Scientific Terms" which are listed below, with some amendments. Where other abbreviations are standard in certain types of work, they can be used if accompanied by definitions. In addition, abbreviations of certain other terms frequently used in special types of reports have been approved for use after figures in those reports, even in text; these include cfs (cubic foot or feet per second), mgd (million gallons per day), gpd (gallon or gallons per day), gpm (gallon or gallons per minute), and ppm (part or parts per million).

The omission of the period after most of the listed abbreviations should be noted.

Abbreviations for scientific and engineering terms

absolute	abs
acre	spell out
acre-foot, -feet	acre-ft, ac-ft [1]
alternating-current (unit modifier).	a-c
altitude	alt
ampere	amp
ampere-hour	amp-hr
angstrom unit	A
antilogarithm	antilog
approximate	approx
atmosphere	atm
atomic weight	at. wt
average	avg
avoirdupois	avdp
azimuth	az or α
barometer	bar.
barrel	bbl
Baumé	Bé
billion electron volts	Bev
biochemical oxygen demand.	BOD [2]
boiling point	bp
brake horsepower-hour	bhp-hr
Brinell hardness number.	Bhn
British thermal unit	Btu or B [3]
bushel	bu
calculated	calc
calorie	cal
candle	c
candle-hour	c-hr
candlepower	cp
center to center	c to c
centigram	cg
centiliter	cl
centimeter	cm
centimeter-gram-second (system).	cgs
chemically pure	cp
circular (shape)	cir
circular mils	cir mils
coefficient	coef
cologarithm	colog
concentrate	conc
conductivity	cond
constant	const
cosecant	csc
cosine	cos
cotangent	cot
cubic	cu
cubic centimeter	cc, cu cm, cm^3
cubic feet per minute	cfm
cubic feet per second	cfs
cubic feet per second per square mile.	cfsm [4]
cubic foot	cu ft
cubic inch	cu in.
cubic meter	cu m or m^3
cubic micron	cuμ or cu mu or μ^3
cubic millimeter	cu mm or mm^3
cubic yard	cu yd
cycles per second	spell out or c
cylinder	cyl
decibel	db
degree	deg [5] or °
degree centigrade	°C
degree Fahrenheit	°F
degree Kelvin	°K
degree Réaumur	°R
diameter	diam
direct-current (unit modifier).	d-c
dozen	doz
dram	dr
dyne	d

[1] The abbreviation ac-ft is to be used only in boxheads of annual reports on surface water and of flood reports.

[2] BOD is to be used in annual reports describing quality of water and in certain other reports.

[3] B is abbreviation recommended by the Power Test Codes Committee, American Society of Mechanical Engineers. B = 1 Btu. Others are kB = 1,000 Btu, mB = 1,000,000 Btu. The American Society of Heating and Ventilating Engineers recommends the use of Mb = 1,000 Btu and Mbh = 1,000 Btu per hr.

[4] The abbreviation cfsm is to be used only in boxheads of annual reports on surface water and of flood reports. In text, after a figure, use "cfs per sq mi." Do not use "cfs/sq mi."

[5] There are circumstances under which one or the other of these forms is preferred. In general the sign (°) is used where space conditions make it necessary, as in tabular matter, and when abbreviations are cumbersome, as in most angular measurements, such as 59°23′42″. In the interest of simplicity and clarity, the abbreviation for the temperature scale, F, C, or K, should follow the degree sign, without space.

Abbreviations for scientific and engineering terms—Continued

efficiency	eff
electric	elec
electromagnetic units	emu
electromotive force	emf
electron volt	ev
elevation	elev
erg	spell out
equation	eq
external	ext
farad	spell out or f
feet per minute	fpm
feet per second	fps
fluid	fl
foot	ft
foot-candle	ft-c
foot-Lambert	ft-L
foot-pound	ft-lb
foot-pound-second (system).	fps
foot-second (see "cubic feet per second").	
freezing point	fp
fusion point	fnp
gallon	gal
gallons per day	gpd
gallons per minute	gpm
gallons per second	gps
gram	g
gram-atom	g-atom
gram-calorie	g-cal
henry	h
high-pressure (unit modifier).	h-p
horsepower	hp
horsepower hour	hp-hr
hour	hr
hour (in astrophysical, seismological, and similar scientific matter).	h
hundred	C
hyperbolic cosine	cosh
hyperbolic sine	sinh
hyperbolic tangent	tanh
inch	in.[6]
inch-pound	in-lb
inches per second	ips
inside diameter	ID
intermediate-pressure (unit modifier).	i-p
internal	int
joule	j
kilocalorie	kcal
kilocycles per second	kc
kilogram	kg
kilogram-calorie	kg-cal
kilogram-meter	kg-m
kilograms per cubic meter.	kg per cu m
kilograms per second	kgps
kiloliter	kl
kilometer	km
kilometers per second	kmps
kilovolt	kv
kilovolt-ampere	kva
kilowatt	kw
kilowatthour	kwhr
latitude	lat or ϕ
least common multiple	lcm
linear foot	lin ft
liquid	liq
liter	l
logarithm (common)	log
logarithm (natural)	ln
longitude	long. or λ [7]
low-pressure (unit modifier).	l-p
lumen	l
lumen-hour	l-hr
lumens per watt	lpw
mathematics (ical)	math
maximum	max
mean effective pressure	mep
melting point	mp
meter	m
meter-kilogram	m-kg
mho	spell out
microampere	μa or mu a
microcurie	μc
microfarad	μf or mf
microgram	μg
microgram-atom	μg-atom

[6] When used with "ft, lb, etc." the period may be omitted.

[7] When used with lat, the period may be omitted.

Abbreviations for scientific and engineering terms—Continued

microhenry	μh
microinch	μin.
micromicrofarad	μμf or mmf
micromicron	μμ or mu mu
micron	μ or mu
microroentgen	μr
microsecond	μsec
microvolt	μv
microwatt	μw or mu w
miles per hour	mph
miles per hour per second	mphps
milliampere	ma
milligal	mgal
milligram	mg
milligram-atom	mg-atom
millihenry	mh
milliliter	ml
millimeter	mm
millimicron	mμ or m mu
million (combining forms only).	meg-, mega-
million electron volts	Mev
million gallons per day	mgd
milliroentgen	mr
millivolt	mv
milliwatt	mw
minimum	min
minute	min
minute (angular measure).	′
minute (time, in physical tables).	m
mole	spell out
molecular weight	mol. wt
most probable number	mpn
ohm	spell out or Ω
ohm-centimeter	ohm-cm
ohm-meter	ohm-m
ounce	oz
ounce-foot	oz-ft
ounce-inch	oz-in
outside diameter	OD
part(s) per million	ppm
peck	pk
pennyweight	dwt
pint	pt
potential	spell out
potential difference	spell out
pound	lb
pound-foot	lb-ft
pound-inch	lb-in
pounds per brake horsepower-hour.	lb per bhp-hr
pounds per cubic foot	lb per cu ft
pounds per square foot	psf
pounds per square inch	psi
pounds per square inch absolute.	psia
power factor	spell out or pf
quart	qt
radio frequency	rf
reactive kilovolt-ampere.	kvar
reactive volt-ampere	var
revolutions per minute	rpm
revolutions per second	rps
root mean square	rms
secant	sec
second	sec
second (angular measure).	″
second-foot, -feet (see "cubic feet per second").	
second (time, in physical tables).	s
shaft horsepower	shp
sine	sin
sine of the amplitude (an elliptic function).	sn
specific gravity	sp gr
specific heat	sp ht
square	sq
square centimeter	sq cm or cm^2
square foot	sq ft
square inch	sq in.
square kilometer	sq km or km^2
square meter	sq m or m^2
square micron	sq μ, sq mu, or μ^2
square mile	sq mi
square millimeter	sq mm or mm^2
square root of mean square (root mean square).	rms
standard	std
stere	s
tangent	tan
temperature	temp

Abbreviations for scientific and engineering terms—Continued

tensile strength	ts
thousand	M, K, kil-, kilo-
thousand electron volts	Kev
thousand foot-pounds	kip-ft
thousand pounds	kip
ton	spell out
ton-mile	spell out
versed sine	vers
volt	v
volt-ampere	va
watt	w
watthour	whr
watts per candle	wpc
week	spell out
weight	wt
yard	yd
year	yr

Terms denoting units of measurement should be abbreviated only when preceded by the amount indicated in numerals. Thus write, "expressed in million gallons per day" or "several million gallons a day" but "3 mgd." Short words such as ton, day, and mile should be spelled out. Abbreviations should not be used when the meaning will not be clear; if there is any doubt, spell out the word. If it is desirable to use an unfamiliar abbreviation (perhaps because of the number of repetitions), the first use of the abbreviation should be followed by the spelled-out form in parentheses, or in a footnote or headnote if used in tables.

Abbreviations may be used also for geographic terms, for addresses, in descriptions of tracts of land, in names and titles, in terms relating to Congress, and in dates.

In other than formal usage, the words "United States" are abbreviated where they precede the word "Government" or the name of a Government organization. The names of foreign countries, except U. S. S. R., are not abbreviated. In other than formal usage, Canal Zone, Puerto Rico, Territory of Hawaii, Virgin Islands, and the names of States of the United States except Idaho, Iowa, Maine, Ohio, and Utah are abbreviated where they immediately follow a geographic name. Alaska is not abbreviated.

Ala.	Ga.	Miss.	N. Y.	T. H.
Ariz.	Ill.	Mo.	Okla.	Va.
Ark.	Ind.	Mont.	Oreg.	V. I.
Calif.	Kans.	Nebr.	Pa.	Vt.
Colo.	Ky.	Nev.	P. R.	Wash.
Conn.	La.	N. C.	R. I.	W. Va.
C. Z.	Mass.	N. Dak.	S. C.	Wis.
D. C.	Md.	N. H.	S. Dak.	Wyo.
Del.	Mich.	N. J.	Tenn.	
Fla.	Minn.	N. Mex.	Tex.	

The names of States are spelled out after a lowercased word, such as "area," "basin," "region," "district," or "quadrangle."

The names of other insular possessions and trust territories, Alaska, and such names as Long Island and Staten Island are not abbreviated. The words "street," "avenue," "building," and similar terms following a name or number may be abbreviated in footnotes, tables, and leaderwork, as in "2912 14th St.," but should always be spelled out when they are part of a name, as in "14th Street Bridge." The words "county," "fort," "mount," "point," and "port" are not abbreviated. "Saint" in names is abbreviated.

In referring to public-land divisions use the following forms: "In the NE¼SW¼ sec. 25, T. 5 N., R. 14 E., is a hill composed of granite"; "in the N½ sec. 25"; "in sec. 25"; "secs. 2 and 3"; "Tps. 4 and 5 S."; "Rs. 14 and 15 W."; "T. 13 N., Rs. 7 and 8 E. (or Rs. 7–8 E.)"; and "SE cor. sec. 5, T. 4 N., R. 6 E."

The words "latitude" and "longitude" followed by figures are abbreviated, and the figures are closed up: lat 52°33′05″ N.; long 13°21′10″ E.

In the names of business firms, if it is not necessary to preserve the full legal title, the forms "Bros.," "Co.," "Corp.," "Inc.," "Ltd.," and "&" should be used. Names of railroads should not be abbreviated except in footnotes, tables, etc. Use the correct form, "Railroad" or "Railway." In other than formal usage a civil, military, or naval title preceding a name is abbreviated if followed by a Christian name or initial: "My dear Colonel Smith" (in the salutation of a letter); "Colonel Smith furnished data on the wells * * *"; but "Col. H. M. Smith furnished * * *."

Uses of "percentage" and "percent" are—a small percentage (or proportion), 20 percent. Do not use %. Use "percent" only with figures. The only exception to this rule is the term "percent sodium," which is used with or without figures, as in "The water has a high percent sodium" and "The water has a percent sodium of 67."

In abbreviating "number," meaning a serial number, use "No." (capitalized). But use "no." (lowercased) in citations of publications. Do not use the symbol #.

The degree mark should be used with figures in statements of dips and strikes, and the terms of direction should be abbreviated: "A dip of 10° SE. (or 10° S. 35° E.)"; "the strike is N. 55° E. (or N. 45°–70° E.)"; N. 55°30′25″ E.; but "the dip is southeast"—that is, terms of direction should be spelled out unless figures are given.

Use "a. m." and "p. m." with figures denoting clock time, and use a colon between hours and minutes (4:30 p. m.).

Use "feet" and "inches," not the symbols ′ and ″. Over a figure column use "Feet," "Ft in," "(feet)," or "(ft in)," according to the content of the column, whether the term stands by itself or follows another heading such as "Thickness," and the amount of space available.

TABLES AND LEADERWORK

The purpose of a table is to present in a concise and orderly manner information that could not be presented so clearly in any other way. Leaderwork is a simple form of tabulation, in which usually only 2 to 4 columns are used, printed without vertical or horizontal rules. A table should deal with a single subject or should bring together related information for purposes of comparison. Some authors attempt to put into a single table matter that should be in separate tables or left in text. Remarks and explanations should be kept to a minimum within the table.

A table preferably should be introduced by some statement in the text, but such a statement should not duplicate matter in the table heading. As a rule, each table or leaderwork statement should be provided with a concise clear heading that indicates the principal items of information included. Some short tabulations, however, do not need a heading if they are introduced in the text with some such statement as "The following table shows * * *" or "As shown below * * *."

The words "Table showing" should not be used in the heading, nor is it necessary to include in the heading minor items that are incidental to the main features. The heading of a statistical table generally should begin with a concrete rather than an abstract term. For example, "Gold produced in the Willow Creek district in 1933" generally would be better than "Amount of gold produced * * *," although in certain reports it might be desirable to add "amount of" to emphasize that point.

Many tables are numbered for convenience of reference; others are not numbered. A table that can immediately follow the only reference to it should not be numbered; it is of interest only in connection with the text that precedes it. In a report having few tables, all tables or none may be numbered. A report containing many small unnumbered tables of analyses, each of which pertains only to the preceding discussion, also can have numbered tables.

A table is numbered if it does not immediately follow its reference, if it is on a page with other unnumbered tables, or if it is printed on a separate sheet to be tipped in or put in a pocket. Arabic numerals should be used (table 1, not table I or table No. 1).

Several factors govern the position of a table: It may need to be unbroken; it may be set the long way on the page; it may occupy two or more consecutive pages; its length or its necessary association with similar tables may require placing it elsewhere in the report than at the place of its principal reference.

Each manuscript table should be on a separate page or group of pages because the tables and leaderwork, if set in type, are set on composing machines different from those used for text.

Tables are reproduced directly from offset copy, or they are set in type by nonprofessional employees. A prime requisite of a manuscript table is legibility, and the writing should not be crowded. Wherever practical, offset copy for tables in Survey-issued reports should be used, for direct reproduction.

Geologic sections should be top side up—the beds are listed in the order in which they would be shown in a graphic section or drawing, the youngest at the top and the oldest at the bottom. The beds in a section should not be numbered unless the numbers are needed for convenient reference in other parts of the text. If the beds must be numbered, it is permissible to begin numbering either from the top or from the bottom, depending on the purpose of the section.

The rock term is given first in the geologic sections and is followed by the descriptive terms. The purpose of this form is to give emphasis to the material in each bed rather than to its particular color, texture, or other features, but the device is effective only where the term to be emphasized comes first in the line; hence, it is unnecessary to invert the second term in a unit that includes material of two kinds: "Shale, sandy, and fine-grained sandstone" (not "and sandstone, fine-grained"). Note that hyphens are used between words combined to form unit modifiers that immediately follow the principal term and that are ordinarily hyphened. In other words, the unit modifiers read back to the noun and are hyphened as though they preceded it. It is not proper to read back beyond a semicolon or a period because the matter that follows such punctuation is not part of the first statement.

All beds should have the elements in their description in the same order, and all the sections in a report should be consistent in this point. The sections may give the composition, color, and grain size—in that order, but in another report a different order for the descriptive terms may be more useful.

Parts of a foot may be expressed either as inches or as decimals, but the use should be consistent in a given report. In columns of

figures under "Ft in," if only feet are given, supply a zero under "in"; if only inches are given, do not supply a zero under "Ft." (See the geologic section below.)

Section of the Cloverly formation in NE¼NE¼ sec. 19, T. 52 N., R. 101 W.

	Ft	in
Cretaceous:		
Thermopolis shale.		
Cloverly formation:		
Shale, gray; buff sandy shale	10	0
Sandstone, soft, buff; alternating beds of hard brown sandstone	8	0
Shale, sandy; shale and shaly sandstone	21	0
Sandstone, buff, thin-bedded, resistant; weathers brown		8
Sandstone, shaly, and thin beds of buff and gray sandstone	9	6
Sandstone, buff; weathers brown		6
Sandstone, buff, thin-bedded	6	0
Shale, sandy, gray, and shaly buff sandstone	18	0
Sandstone, buff; shaly gray to buff sandstone	3	0
Sandstone, dark-brown, ledge-forming		6
Shale, gray and buff; sandy shale; ripple-marked sandstone at top	17	0
Sandstone, buff, thin-bedded; ripple-marked at top	3	6
Shale, gray and buff; sandy shale	10	0
Shale, sandy, limonitic, brown and yellow; locally forms brown ironstone		6
Sandstone, buff, ledge-forming	8	0
Sandstone, gray; alternates with gray sandy shale	2	0
	118	2
Jurassic:		
Morrison formation.		

The preceding geologic section shows the tabulated form of most printed sections. A more elaborate form for such sections is given on page 209. The manner of centering, the alinement, and the position of "Unconformity" should be noted especially.

In tabulating analyses the name of the analyst (with initials) should be given, in the form "W. F. Hillebrand, analyst" immediately below the heading or in a footnote. If the samples are numbered use arabic numerals (1, 2, 3), not Roman numerals (I, II, III). The term "percent" is not necessary above the figure column if the total approximates 100.

Generalized section of the Wingate sandstone and Jurassic and Cretaceous strata in part of southwestern Colorado and adjoining parts of Utah

System	Group	Formation	Thickness (feet)	Character and distribution
Cretaceous		Mesaverde formation	1,000±	Light-colored sandstone and gray shale; coal bearing; cliff forming; widespread.
		Mancos shale	2,000–5,000	Gray shale; forms valleys and steep slopes; widespread.
		Dakota sandstone	0–200	Gray and brown sandstone and shale; mesa capping; widespread.
		——Unconformity——		
		Burro Canyon formation	50–250	Light-colored conglomeratic sandstone and maroon and green mudstone; mesa capping.
Jurassic		Morrison formation	300–500	Brushy Basin member: varicolored shale (or mudstone), some sandstone lenses; forms slopes; widespread.
			200–400	Salt Wash member: light-colored sandstone and red mudstone; forms cliffs and benches; carnotite bearing; widespread.
	San Rafael group	Summerville formation	0–400	Red and gray shale, thin sandstone; forms slopes; thickens westward.
		Curtis formation	0–250	Glauconitic sandstone, greenish shale, gypsum; present only in central Utah.
		Entrada sandstone	50–1,000	Light-colored massive, cliff-forming sandstone in Colorado and eastern Utah; thickens westward and becomes red earthy sandstone; vanadium bearing.
		Carmel formation	0–600	Red earthy sandstone in Colorado and eastern Utah; thickens westward and becomes gray and red shale; limestone and gypsum.
		——Unconformity——		
	Glen Canyon group	Navajo sandstone	0–2,000	Light-colored massive sandstone; cliff forming; thins to extinction in western Colorado; thickens westward.
Jurassic(?)		Kayenta formation	0–300	Red sandstone, irregularly bedded; bench forming; absent in eastern part of region.
Triassic		Wingate sandstone	0–400	Red massive sandstone; cliff forming; absent in eastern part of region.

Analytical data in Survey reports should contain reference to laboratory records adequate to identify the sample or other material examined.

A suitable form for simple well or drill-hole records appears on page 210. If descriptions are very short it is not necessary to put the

rock term first. However, a consistent style should be followed throughout a report.

Log of Louisville & Nashville Railroad well, Brownsville, Tenn.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
No record	5	5	Sand, white, streaked with clay	121	186
Clay, red	10	15	Sand, coarse	51	237
Clay, hard, white	8	23	Clay, very hard	9	246
Sand, dry, red	8	31	Sand, medium-grained, white, water-bearing	39	285
Sand and clay	9	40			
Clay, blue, and sand	25	65			

Tables for a report on an area containing many wells, springs, and streams may include various kinds of data. In preparing such complex tables it is especially desirable to review published tables for the general form and details of statement. The items to be included may vary according to local conditions. A few examples of arrangement are given below.

A table similar to the one on page 212 might contain a column headed "Stratigraphic unit" instead of "Geologic source," which would give the formation name in place of the lithologic symbol.

Water-level data are typed in two columns but may be set in half or third measure as in the following table:

TABLE 8.—*Measurements of the water level in wells*

[In feet below land-surface datum]

Date	Water level	Date	Water level	Date	Water level
17–4–36aa					
1948		*1949*		*1950*	
May 18	4. 11	Nov. 4	4. 63	Apr. 24	4. 06
Sept. 28	5. 15	Dec. 2	4. 85	May 24	3. 84
				June 23	4. 39
1949		*1950*		July 26	3. 12
Apr. 26	2. 93	Jan. 10	4. 89	Aug. 25	4. 66
June 6	2. 73	Feb. 8	4. 77	Oct. 6	5. 11
July 6	2. 57	Mar. 3	4. 24	Nov. 2	5. 21
Aug. 8	4. 47	Mar. 29	3. 48	Nov. 28	5. 17
Sept. 21	4. 35	Apr. 12	3. 60		

TABLE 6.—*Records of wells*

Well number: See p. 17 for description of well-numbering system.
Type of well: B, bored; Dn, driven; Dr, drilled; Du, dug.
Depth of well: Reported depths below land surface are given in feet; measured depths are given in feet and tenths.
Type of casing: C, concrete (includes brick or tile); P, iron or steel pipe; S, stone; T, clay tile; W, wood.
Water-bearing material: Cl, clay; G, gravel; L, lignite; S, sand; SiS, silty sand; Ss, sandstone.
Type of pump: Cy, cylinder; J, jet; N, none; P, pitcher pump; R, rotary; VC, vertical centrifugal; F indicates flowing well; yield, in gallons per minute, in parentheses,
Use of water: D, domestic; N, not used; O, observation; P, public supply; S, stock.
Measuring point: Bp, base of pump; Esp, end of spout; Hp, hole in pump; Hpb, hole in pump base; Hc, hole in casing; L, land surface; Tca, top of casing; Tco, top of cover; Tcu, top of curb; Tp, top of pump; Twb, top of wooden box.
Depth to water: Reported depths are given in feet below land surface; measured depths are given in feet, tenths, and hundredths below measuring point.
Remarks: Ca, chemical analysis made of water; L, log of well included in report.

Well	Owner or tenant	Type of well	Depth of well below land surface (feet)	Diameter of well (inches)	Type of casing	Water-bearing material	Type of pump	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement	Remarks
									Description	Distance above or below (—) land surface (feet)	Altitude above mean sea level (feet)			
Eastern segment, McLean County														
147-86-4cba	Florence Barr	Dr	214	4	P	Ss	Cy	D, S			1,917	144	1949	
6bda	Frank Johnson	B	100.4	18	W		Cy	D, S	Tco	0.8	1,880	83.33	11-16-49	
7bad	John Kovarik	B	40	18	W	L	Cy	S	Tco	.6	1,893	16.31	do	
147-87-12bab	Matthew Whitebear, Sr	Dr	464.8	4	P	S	N	D	Tca	1.7		207.28	10-23-51	L
13bcb	Matthew Whitebear, Jr	Dr	261.4	4	P	S	N	D	Tca	2.3		206.77	10-10-51	L
147-87-16cdd	Jackson Ripley	Du	84.5	24	W		Cy	D, S, O	Tco	.2	1,781	73.70	11-18-49	
17ca	Byron Wilde	Dr	130	4	P	S	Cy	D,O	Hpb	1.0	1,802	84.57	do	Ca
18cbb	Henry Brewer	B	81.8	24	W	S	Cy	D,S	Tco	.6	1,777	73.09	do	
18daa	Thomas White	Dr	91.4	4	P		Cy	D	Tca	1.5	1,782	72.44	do	
19ccc	George Karlin	Du	6.3	24	T	S,G	R	D	Tca	1.2	1,720	5.45	11-21-49	
29bad	Matthew Whitebear, Sr	Dr	21.9	8	P		Cy	S	Bp	.9	1,738	11.87	11-18-49	
29daa	Davis Painte	B	36.6	24	W		Cy	D	Tco	.5	1,724	16.00	do	
29dba	Eleanor Whitebear	B	38.5	24	W		Cy	S	Tco	.2	1,731	14.77	do	
30bab	Alfred Kreuger	Dn	7.0	1	P	S	F(10)	D, S	Bp	3.5	1,720	8.55	11-21-49	
147-88-1dcc	Oren Taylor	B	152.6	24	W	L	Cy	D, S	Hpb	.4	2,003	137.39	1949	

[Absence of cross rule here indicates table is continued on next page. Date column shows style used for crowded table]

TABLE 7.—*Records of springs*

Geologic source: A, alluvium; C, clinker; G, gravel, undifferentiated; Ga, alluvial gravel; Gd, glacial drift; L, lignite; S, sand; Ss, sandstone.

Use of water: D, domestic; N, none; S, stock.
Flow: E, estimated; M, measured.

Spring	Owner	Topographic situation	Geologic source	Use of water	Altitude above mean sea level (feet)	Flow (gpm)	Date of observation
							1949
147-87-5acb	Tribal land	Side of coulee	L	S		0.3 E	Aug. 17
5acd	Virginia Gerard	Bottom of coulee	L(?)	N	1,932	1 E	Aug. 12
5dca1	do	Coulee bank	L	N		.1 E	Aug. 5
5dca2	do	Side of coulee	L	S		1 E	Aug. 7
6dcb	Tribal land	Side slope of coulee	L	S	1,942	1.5 E	Dec. 5
7abb	Oscar J. Howard	Bottom of coulee at valley side	L	S	1,861	3 E	Aug. 17
7bba	Rose Howard	Side slope of coulee	L	S	1,915	1 E	Dec. 11
8aaa	Tribal land	Coulee	L	S		2 E	Dec. 6
8abb	Josephine Gerard	Side of coulee	L	S		3 E	Aug. 5
10acd	White Basket	do		N	1,894	.1 E	Aug. 9
12dcd	Tribal land	do	L	S	1,855	.5 E	Aug. 8
13acd	Fort Stevenson Military Reservation	Head of coulee	L	S	1,770	.5 E	Aug. 8
17aad	Anna D. Wilde	Side of coulee	L	N		.5 E	Aug. 10
17bbc	Byron Wilde	Bottom of small coulee	L	S		1 E	Sept. 2
147-88-4cbb	Elizabeth Price	do	C	S		1 E	Sept. 9
4dac	Mother Bed	Valley side	L	D	1,962	.7 M	Sept. 7
5bcb	Philomena Felix	do	L	D,S	1,926	15 E	Nov. 2
9dbc	Polly Wells	Side of coulee	L	D	1,878	.3 E	Sept. 6
9dbd	do	Valley side	L	N		1 E	Aug. 23
11bad	Peter Beauchamp	Bottom of coulee, near head	L	S	1,920	4 E	Aug. 8
13cab	Sybert Perkins	Side slope	L(?)	N	1,819	.1 E	Aug. 22
13cca	White Calf	Base of bluff	L	D,S	1,760	2.7 M	Aug. 22
14bdd	Levi Waters	Side of coulee	L	S	1,822	2 E	Aug. 22
19bcd	Bull Head	Side slope	L			.5 E	Sept. 1
22baa	Out of His Head	Head of coulee		S		1 E	Sept. 2

[Cross rule indicates that table ends here. Date column set in standard style]

SAPPA CREEK NEAR STAMFORD, NEBR.

Suspended sediment, water year October 1949 to September 1950—Continued

Day	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day	Mean discharge (cfs)	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Tons per day
	April			May			June		
1	36	217	21	35	187	18	146	5,260	2,070
2	44	241	29	34	187	17	148	3,530	1,410
3	43	233	27	38	132	14	140	3,530	1,330
4	39	206	22	35	116	11	111	3,070	920
5	36	197	19	37	184	18	91	3,030	744
6	33	194	17	58	----------	* 340	67	1,770	320
7	35	146	14	49	3,340	442	53	1,070	153
8	35			38	1,650	169	46	810	100
9	38			38	410	42	40	676	73
10	38	158	16	37	280	28	36	592	58
11	35			36	240	23	34	519	48
12	38			152	----------	* 3,200	33	460	41
13	37	120	12	142	6,270	2,400	32	413	36
14	38			89	3,420	822	31	393	33
15	36			49	2,500	331	30	388	31
16	37			48	1,350	175	27	384	28
17	40			49	860	114	26	350	24
18	44	132	14	39	640	67	25	309	21
19	41			38	550	56	24	303	20
20	38			93	3,460	* 1,480	25	303	20
21	38			103	5,710	1,590	25	283	19
22	39			89	3,320	798	23	270	17
23	40	142	15	54	3,240	472	22	242	14
24	40			43	1,330	154	21	212	12
25	38			34	920	84	20	183	10
26	37			32	610	53	18	184	9
27	36	110	11	39	----------	* 75	16	204	9
28	35			248	----------	* 4,900	15	235	10
29	35			665	7,540	13,500	15	237	10
30	35	88	8	753	6,060	12,300	17	238	11
31	----------	----------	----------	271	5,940	4,370	----------	----------	----------
Total	1,134	----------	456	3,465	----------	48,060	1,357	----------	7,600
	July			August			September		
1	26	----------	* 340	940	7,110	* 18,700	324	5,390	4,710
2	117	7,220	2,280	914	5,060	12,500	195	4,000	2,100
3	53	3,690	528	366	4,380	4,330	158	2,400	1,020
4	63	3,640	* 1,090	347	3,530	3,310	121	2,040	666
5	170	----------	* 3,500	313	3,180	2,690	101	1,080	294
6	125	6,980	2,360	225	2,530	1,540	90	736	179
7	191	----------	* 3,900	787	8,240	17,500	82	599	133
8	92	5,660	1,400	2,220	4,510	* 25,300	75	470	95
9	74	4,080	815	2,360	2,940	18,700	73	430	85
10	42	3,620	410	548	4,440	6,570	68	391	72
11	82	----------	* 1,200	445	3,380	4,060	65	342	60
12	89	4,740	1,140	982	5,880	* 16,100	64	293	51
13	376	7,320	* 10,400	784	5,920	12,500	63	272	46
14	980	6,720	17,800	823	8,130	18,100	61	270	44
15	936	4,350	11,000	608	7,950	* 13,500	59	257	41
16	367	3,560	3,530	249	3,620	2,430	58	268	42
17	136	3,050	1,120	202	2,220	1,210	57	249	38
18	91	2,170	533	186	1,580	793	56	243	37
19	332	6,970	* 9,290	226	----------	* 1,700	54	215	31
20	553	9,550	14,200	270	3,520	2,560	52	205	29
21	284	5,680	4,360	261	1,960	1,380	50	179	24
22	134	4,200	1,520	243	1,930	1,270	49	153	20
23	492	7,820	* 13,300	186	1,860	934	47	143	18
24	656	8,050	14,200	157	1,560	661	46	143	18
25	316	5,600	4,780	133	1,300	467	48	148	19
26	182	3,090	1,520	147	1,960	778	43	126	15
27	800	9,270	* 20,900	202	2,880	1,570	42	121	14
28	1,460	3,940	15,500	177	3,150	1,500	41	112	12
29	2,080	2,880	16,200	628	7,840	* 15,000	41	180	20
30	1,850	3,060	* 14,500	604	5,380	8,770	37	165	16
31	553	4,200	6,270	323	5,700	4,970	----------	----------	----------
Total	13,702	----------	199,900	16,856	----------	221,400	2,320	----------	9,950
Total discharge for year (cfs-days)									45,083
Total load for year (tons)									498,600

Estimated. * Computed by subdividing day.

446304 O—58——15

TABLE 6.—*Chemical analyses of*

[Results in parts per million except as indicated. Municipality: D, sample collected from distribution
ment; USGS, U. S.

Municipality	Well location	Depth of well (feet)	Date of collection	Agency making analysis	Iron (Fe)	Manganese (Mn)	Calcium (Ca)
U. S. Public Health Service drinking-water standards					0. 3		
Central City S	13–6–9ca	40	4–14–47	USGS	0. 04		105
Do		39–41	1947–48	NSHD	. 02	0. 26	
Columbus S	A17–1–20bc	84	4–14–47	USGS	. 50		106
Do		84–88	1947–48	NSHD	. 03	. 5	
Columbus D		84–88	1947–48	NSHD	2. 9	. 39	
Columbus S		84–88	1949–50	NSHD	. 11	. 3	
Columbus D		84–88	1949–50	NSHD	. 01	. 02	
Fullerton D		32–42	1947–48	NSHD	0	0	
Genoa S		35–40	1948–49	NSHD	. 01	0	
Grand Island S	11–9–21cc	82	4–4–47	USGS	. 24		61
Do	27bb	113	4–4–47	USGS	. 06		71
Do		76–113	1947–48	NSHD	0	0	
Grand Island D		76–113	1947–48	NSHD	0	0	
Do		76–113	1949–50	NSHD	0	0	
Monroe D		76	1947–48	NSHD	0	0	
Palmer S		76	1947–48	NSHD	1. 2	. 3	
Palmer D		76	1947–48	NSHD	. 58	0	
Silver Creek S	16–3–33db	32	4–14–47	USGS	. 67		123
Do		32–36	1947–48	NSHD	. 48	. 22	
Silver Creek D		32–36	1947–48	NSHD	. 14	. 27	

water from municipal supplies

system; S, sample collected at source. Agency making analysis: NSHD, Nebraska State Health Depart Geological Survey]

Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Solids		Hardness as $CaCO_3$		Percent sodium	pH
									Dissolved (residue on evaporation at 180°C)	Total	Calcium, magnesium	Noncarbonate		
125	----	----	----	250	250	1. 5	-----	-----	500	----	----	----	----	----
19	20		256	127	17	0. 4	20	0. 14	471	----	340	130	11	7. 6
----	----	----	----	137	18	. 5	17	-----	----	601	228	----	----	7. 2
18	23		382	56	11	. 2	. 3	. 08	449	----	338	25	13	7. 7
----	----	----	----	54	39	----	-----	-----	----	470	244	----	----	7. 5
----	----	----	----	54	19	. 3	. 4	-----	----	398	183	----	----	7. 3
----	----	----	----	96	48	. 4	-----	-----	----	400	361	----	----	7. 4
----	----	----	----	80	38	. 4	-----	-----	----	193	140	----	----	8. 6
----	----	----	----	43	29	. 3	19	-----	----	578	238	----	----	7. 4
----	----	----	----	53	11	. 3	19	-----	----	461	252	----	----	7. 2
11	20		155	95	5. 6	. 2	8. 0	-----	305	----	197	70	18	7. 6
22	3. 9		239	65	6. 0	. 3	4. 0	-----	339	----	268	72	3	8. 0
----	----	----	----	52	21	. 2	-----	-----	----	274	151	----	----	7. 2
----	----	----	----	56	21	----	-----	-----	----	270	153	----	----	7. 1
----	----	----	----	69	9. 3	. 2	18	-----	----	294	213	----	----	7. 2
----	----	----	----	26	7	. 1	3. 5	-----	----	353	290	----	----	7. 3
----	----	----	----	0	7	. 5	0	-----	----	329	216	----	----	7. 6
----	----	----	----	4	8	. 5	0	-----	----	315	210	----	----	7. 9
20	31		306	161	24	. 5	4. 0	. 09	541	----	389	138	15	7. 9
----	----	----	----	52	8	. 4	0	-----	----	197	144	----	----	7. 4
----	----	----	----	201	22	. 6	1. 8	-----	----	540	223	----	----	7. 4

ARIKAREE RIVER AT HAIGLER, NEBR.

Particle-size analyses of suspended sediment, November 1949 to August 1950

[Method of analysis: B, bottom withdrawal tube; D, decantation; P, pipette; S, sieve; N, in native water; W, in distilled water; C, chemically dispersed; M, mechanically dispersed]

Date of collection	Time	Discharge (cfs)	Suspended sediment											Method of analysis
			Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters									
					0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	
1949															
Nov. 1	11:05 a. m	26	190	901	22	30	42	52	62	67	71	84			BW
1950															
Feb. 1	11:05 a. m	12	84	1,130	10	17	28	48	66	69	74	89			BW
Feb. 9	4:15 p. m	30	913	1,440	15	22	34	46	61	72	88	97			BW
Feb. 21	8:35 a. m	29	328	1,400	25	34	49	64	72	77	82	94			BW
Feb. 28	9:25 a. m	26	194	861	35	44	53	61	66	70	76	88			BW
May 8	9:40 a. m	129	8,280	6,320		46		71		86	95	100			SPWCM
May 8	11:00 a. m	129	5,720	3,300	31	44	56	68	71	90	96	100			SPWCM
May 8	11:00 a. m	129	5,720	3,340	4	6	31	67	80	92	100				SPN
July 30	6:40 p. m	25	1,810	3,840		79		94		96	100				SPWCM
Aug. 10	12:00 m	190	12,300	8,500		68		88		98	100				SPWCM
Aug. 10	2:00 p. m	123	8,860	4,840		76		90		97	100				SPWCM
Aug. 11	6:00 a. m	70	7,720	5,540		70		87		97	99	100			SPWCM
Aug. 11	12:00 m	54	6,910	5,470	24	33	41	50	58	67	78	90			BWCM
Aug. 12	12:30 p. m	24	1,230	1,710	80	90	96	97	98	99	100				BWCM
Aug. 13	5:30 p. m	38	3,040	1,990	67	72	75	76	78	79	80	88			BWCM
Aug. 14	8:30 a. m	46	1,630	1,080	46	52	58	64	74	82	94	100			BWCM
Aug. 25	9:10 p. m	186	15,600	7,590	28	41	60	81	85	93	96	99	100		SPWCM
Aug. 25	9:10 p. m	186	15,600	7,680	3	6	36	74	90	95	98	100			SPN
Aug. 25	9:20 p. m	186	14,000	4,690		48		81		95	98	100			SPWCM

[Crossrule at bottom indicates end of table. In a narrow date column at left-hand side of table, do not repeat name of month]

Tables enclosed in box rules are narrower than the printing column, consist entirely of figures, and are not leadered. As most tables of this type do not have a heading, it is essential that they be introduced in the sentence immediately preceding.

Altitude of water surface (feet)	Area (acres)	Capacity (acre-feet)
3, 200	0	0
3, 220	27	270
3, 240	77	1, 310
3, 260	166	3, 740
3, 280	405	9, 450
3, 300	832	21, 820
3, 320	1, 060	40, 740

FOOTNOTES TO TABLES

For reference marks in a table to be printed by letterpress, superior figures ([1, 2, 3, etc.) are used. As the references begin with [1] in each table and are not renumbered, the reference marks should be written in the manuscript. Lowercased superior letters may be used instead of numbers if necessary to avoid ambiguity.

The reference mark should be written immediately after the word or matter to which it relates if it is in a heading, in a boxhead, in a reading column, or in a standard date column; and it should be written immediately before the matter to which it relates if it is in a figure or a symbol column. In a figure or date column, a reference mark standing alone should be written between parentheses and centered. Where the last column is a date column, a reference mark is placed at the left. Reference marks should be written in numerical or alphabetical order, beginning in the heading of the table, going across the boxheads, continuing across the top line of the table proper, then across each succeeding line from beginning to end. The footnotes should be written at the bottom of the table, as in the sample below. Note that this table is leadered, set full width of the printed column or the type page, and is not boxed in.

Graphite produced in 1910

Country	Quantity (short tons)	Value
United States [1]	3, 618	$388, 455
Ceylon	[2] 30, 183	[3] 1, 159, 529
Korea	([4])	[5] 56, 000

[1] Mines and Quarries, pt. 4, p. 672, London, 1911.
[2] Figure shows exports.
[3] Subject to correction.
[4] Statistics not available.
[5] Approximate only.

Statements that pertain to the table as a whole, that pertain to all the data in a column, or that will permit the elimination of columns in the table should be placed in brackets as headnotes centered below the title, above the boxheads. Insofar as possible avoid placing footnote references in boxheads.

TYPING THE MANUSCRIPT

Typists who prepare manuscript copy for Geological Survey reports should familiarize themselves with such parts of this volume as are pertinent to their work. They should also examine recent Survey publications, noting the style of the table of contents, footnotes, and other details and making their copy conform to that style. A few additional hints and some repeated directions are given below.

For manuscript copy, use one side of Government letter paper (8 by 10½ inches) and leave a margin of 1 inch on all sides of each page of text. On the first page leave at least 2 inches of space above the title. Temporary page numbers should be placed at the bottom of the pages; final numbers will be placed at the top by the editors. Tables should be typed on separate pages, and a 1-inch margin should be left on all sides. If a report is to be reproduced by photo-offset, a specially typed copy is made for that purpose in accordance with current practices, which are not discussed in this volume.

The title of the report and the author's name should appear not only on the title page but at the top of the first page of text—that is, above the abstract. The author's name is given below the title and is written between dashes, one above and one below. Also, if the report gives the results of a cooperative investigation made under the auspices of two or more organizations, the title page must contain a brief statement on this subject. The cover page also bears an acknowledgment of the cooperation, but that page is set up by the editor, and the typist need not concern herself with it, nor the author except when examining the proof.

In the table of contents, which should be headed "Contents," type main heads "flush"—that is, start them at the left margin of the typing; indent the others in multiples of five spaces, according to their rank. Capitalize in the table of contents only such words as should be capitalized in the text. Type nothing all in capitals and do not underscore anything except words that should be printed in italic, such as the names of fossils. Use leaders to page numbers, which should be given, the pages being those on which the headings appear in the manuscript. If page numbers cannot be supplied when the table of contents is typed they can be inserted later.

"Continued" lines should appear at the head of every page of a table of contents, to show the indention and relative rank of the continued items. (See p. IX–XII of the present volume.)

Type the center and side headings lowercase, capitalizing only the first word and proper names. Do not underscore center headings, but underscore side headings for italic. Follow the side heading with a period and a dash (two hyphens on the typewriter).

The text of a report, including tables, geologic sections, well logs, quotations, footnotes, references, and bibliographies, should be typed double spaced, or triple spaced if desired. This practice provides enough room for editorial marking and may avert the necessity of recopying edited pages. A page having crowded interlineations, no matter how carefully they are written, must be retyped before it can be sent to the printer.

Type titles of text figures with "hanging indention" (see printed reports), not as ordinary paragraphs nor with each line flush.

For reference marks in tables, use "superior" figures (^{1} ^{2} ^{3}) or, in figure columns in tables set up on the typewriter, lowercased letters, not symbols such as the asterisk (*) or the dagger (†). The reference marks should be given in numerical (or alphabetical) order.

Type each footnote in the line immediately below the line of text in which the reference mark occurs, separating it from the text above and below by lines running across the page. Do not break the text at the reference mark if it comes in the middle of a line; insert the reference mark, complete the line, and then insert the footnote.

The heading of a table or section should be underscored for italic. See that units of measure, such as feet, inches, pounds, or tons, are written over columns of figures representing such units. If dimensions are given in feet and inches use the form "Ft in" or "ft in" for the units. (See p. 206, 208.)

Operators using keyboards bearing no figure 1 should use lowercase l (letter) for this numeral. If capital I is used, confusion results—volume II appearing instead of volume 11, for example.

In copying manuscript "spell out" (that is, type in full or in words) any abbreviation or number that is encircled with pen or pencil mark, and type as a small letter any capital letter through which a vertical or diagonal mark has been drawn. A similar mark drawn through a lowercased letter means to delete the letter. Capitalize a lowercased letter beneath which three parallel lines are drawn. Restore a crossed-out passage that is marked "stet" or is underscored with short dashes.

In typing matter that has been edited, follow copy in all respects; do not change the style, punctuation, or wording. The editor has prepared the matter for printing; to disregard his work necessitates his doing the work again. The marks indicating style of type need not be copied. Copied matter should be compared with the original before it is returned to the editor, and the original should be returned with the copy. Carbon copies of such retyped pages are not necessary unless

they are needed for uses other than submittal to the Government Printing Office.

Manuscript copy should be typed so that no paragraph breaks at the bottom of a page. The typist should look ahead to determine whether the next paragraph can be typed on the page. If the paragraph is too long for the page, the last few lines may be typed single spaced. If the paragraph will not fit on a single page, type the remainder of the copy on another sheet, on which nothing else is typed.

Note carefully the following "Don'ts":

Don't capitalize any words except first words, proper nouns, and proper adjectives in the following: the text, the table of contents, the lists of illustrations, the titles of illustrations, the text headings, the table headings, and the citations of publications. But an exception to this rule is "Capitalize the first word and all important words of a title of a book, article, or report quoted in the text." Such titles should be enclosed in quotation marks.

Don't use a comma or period at the end of a line of matter that is followed or should be followed by leaders.

Don't begin a sentence with a figure.

Don't write one figure upon another so as to cover it, producing an uncertain result, as a 3 upon an 8 or a 5 upon a 6. Erase completely the figure first written before correcting.

Don't use 〃 for "Do." or "do.," meaning ditto. In tables use "Do." (capitalized) in first and last columns; "do." elsewhere.

Don't use "Ditto" in any form in figure columns; if successive figures are the same, repeat them.

Don't paste sheets together except to make a table that must be wider than letter paper or to combine parts of a paragraph; use library paste for this purpose. Don't use staples, tape, or rubber cement.

The presence of erasures or of plainly written interlined words or phrases may be tolerated, and pages containing these need not be retyped. A complex table that has been prepared in ink need not be typewritten if the writing is plain in every part, but fine, crowded writing or pale blueprints cannot be accepted. The prime requisite is that the matter should be clearly legible.

Don't crowd anything to save paper. It is impossible to make copy too plain, and room must be left for editorial marking. This direction applies to tables and footnotes as well as to text.

CORRECTING PROOF

PRINTER'S TERMS AND PRACTICES

To the printer, "copy" is manuscript or matter to be set in type. "The matter has been read by copy" means that the manuscript has

been read aloud by a "copyholder" to a proofreader. The proofreader has held the proofsheets in hand and has corrected them to agree with the manuscript except so far as the forms used in the manuscript may contravene the prescribed rules of printing. Unless the matter is to be followed literally (marked "fol." or "fol. lit."), the proofreader will correct apparent errors in spelling, capitalization, and punctuation.

The first proof taken at the Government Printing Office is generally a galley proof, so called because the type is assembled in metal trays, or galleys. On occasion, only a page proof is requested. The first galley proof is read by copy at the Printing Office and is corrected. A second galley proof is then taken, revised (that is, compared with the corrected first galley), and sent to the bureau that submitted the manuscript. Proof received from the Government Printing Office is generally read by the author or by someone acting for him. By bureau and printing-office procedure, the matter next goes into first page proof. The first page proof is submitted to the bureau originating the manuscript, is revised with the galley proof in hand and corrected, and may be approved for printing if it bears only a few corrections. Otherwise a second page proof is requested, and ordinarily this is the final proof, in which (as a rule) only typographic errors can be corrected. The final proof, which includes the index, is approved for printing and returned to the Government Printing Office.

The time that elapses between the date of approval of the page proof for printing and the date of publication may be a few weeks to many months. The printing of a complex colored map may require 6 months or more, and work on the proof of the text of a report may be finished long before the first proof of the map is received.

GENERAL RULES

Galley proof and the printer's copy ordinarily will be sent to the author; page proof also, if that is desirable and practical. The proof will bear marks made by proofreaders and editors—corrections, suggestions, and queries. These marks should be carefully noted, and special attention should be given to question marks on the margins of proofsheets opposite points at which doubt is indicated, inconsistencies are noted, information is wanted, or blanks are to be filled. Failure of the author to note and answer such questions on the galley may require the return of the proof to him.

During the author's examination of galley and page proofs, he must not make corrections or changes on the manuscript, as it is now "printer's copy" and such markings would seem to indicate that the printer had deliberately set other matter than that called for by the copy—or had done a slovenly job. For the same reasons, when

checking page proof the author should not change the galley to make it agree with corrections placed on the page proof.

The approved and edited manuscript is supposed to be complete and accurate. Hence, corrections in proof must be held to a minimum and generally must be confined to correcting printers' mistakes.

PROOFREADER'S MARKS

Although it is not to be expected that an author will be familiar with all the technicalities of proofreading, he should know the significance of the principal marks used in correcting proof and should understand the meaning of the signs made on his proofs so that he can make his own corrections properly. A list of proofreader's marks and a sample of proof marked for corrections are given on pages 223, 224.

Every change or correction desired should be indicated by a conspicuous mark on the margin of the proof opposite the line to which it pertains, not in the body of the printed matter, except as here noted.

To indicate that something should be inserted, place a caret (^) at the point on the line where the insertion should be made, and write the matter to be inserted in the margin, or, if there is not room, on a separate sheet to be pinned to the galley proof. It is not necessary or proper to put a caret in the margin also.

To indicate that something should be taken out and not replaced by something else, draw a line through it and place the "dele mark" (ꝺ), a form of "d" meaning delete (cut out), in the margin.

If something is to be substituted for the matter deleted, do not use either the dele mark or the caret; simply mark through the matter to be replaced and write the substitute matter in the margin or on a separate sheet.

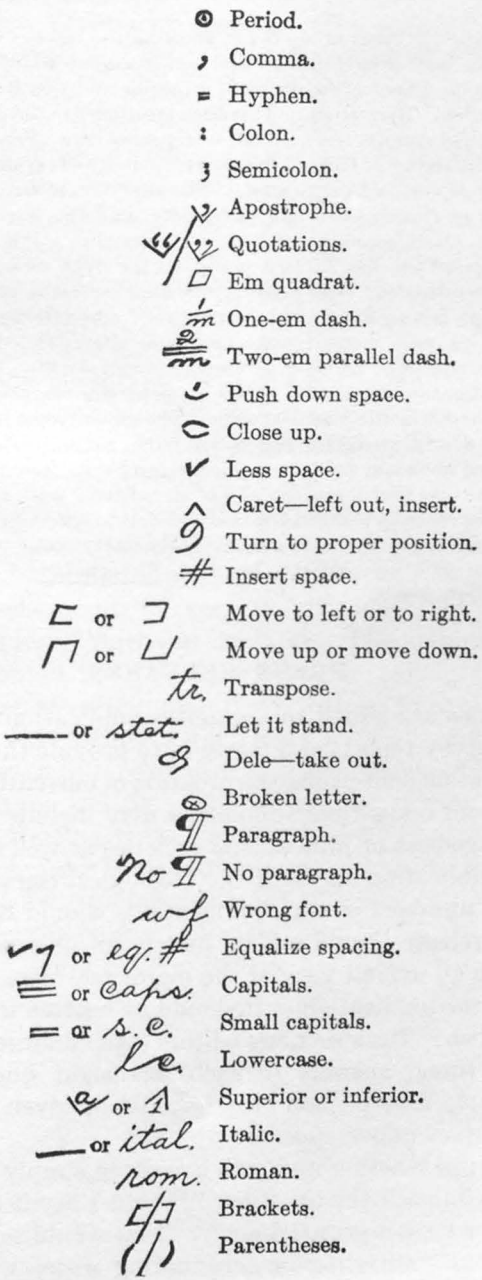
Do not run "skyrocket" marks from the place where a correction should be made to a mark or added matter written at some distant place on the margin of the proofsheet unless there is not room for the correction opposite the line to which it belongs. Do not cross one skyrocket mark with another.

Punctuation and other marks that might be obscure if written alone are placed to the left of a diagonal stroke, thus: ,/ ;/ -/ (comma, semicolon, hyphen). The diagonal stroke is used also to separate one correction from the next where they are crowded in the margin, and to show the end of the corrections. A period to be inserted should be placed in a circle (⊙). The space mark (#) indicates that a space such as is used between two words should be inserted at the place noted by a caret in the body of the proof.

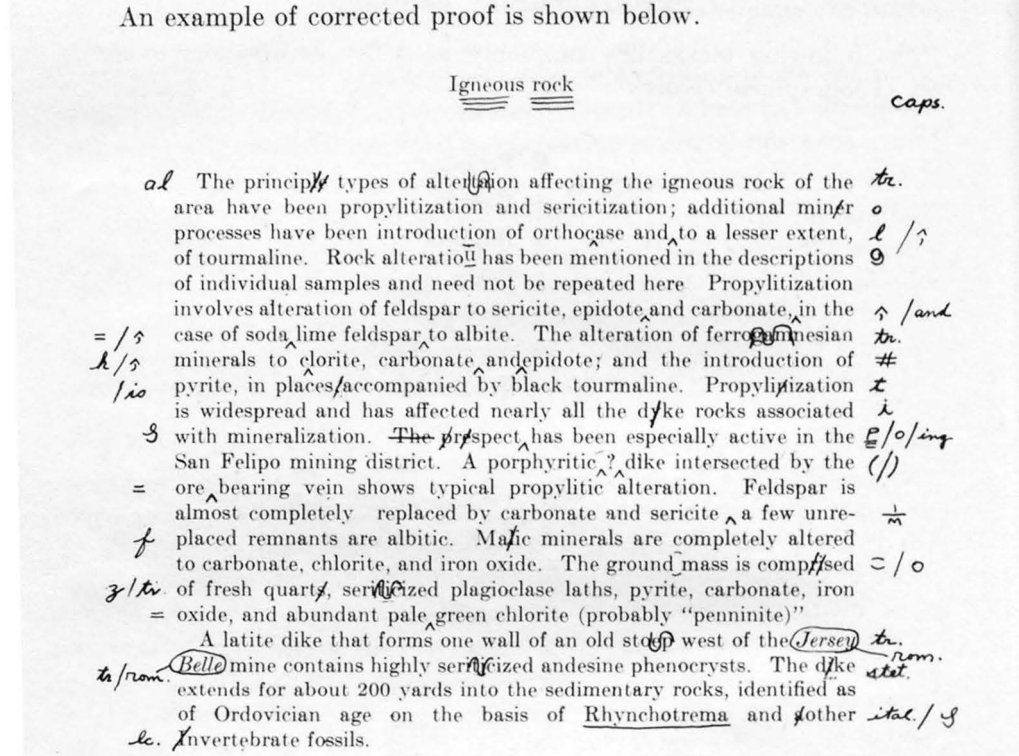
All marks of correction should be made conspicuously and legibly, without possible ambiguity. Because the editorial corrections are made with black pencil, the author should use another color so that his marks can be identified readily.

TYPOGRAPHICAL ERRORS

The following marks are commonly used by proofreaders to correct typographical errors:



An example of corrected proof is shown below.



PRESS RELEASES

Press releases are issued to announce publication or open filing of Geological Survey reports and maps, or to provide the public with pertinent information concerning the progress of currently active projects. The reports and maps thus announced may include those printed by cooperating agencies or professional societies as well as those issued in one of the publication series of the Geological Survey. Exact titles and assigned numbers of such publications should be given.

The press release should not be merely an abstract or annotation; it should give an overall view of the major features, purposes, or contributions of the publication. It should be written in simple, straightforward English. Because news editors depend largely upon what the release tells them, answers to such forthright questions as Who?, When?, What?, Where?, and How? should be given automatically, in the order of their importance.

A good test of whether a release is written simply enough is for the author to ask himself the question, "Would I say it this way if I were talking to my next-door neighbor?" You would not talk with your neighbor about "initiating or terminating water withdrawal" when

you meant "to start or stop pumping." You would not try to tell your neighbor how hot it is in such formal language as "the parameters of ambient temperatures prevailing at subject location are not considered conducive to median satisfaction."

Keep the leading paragraph short and to the point. Give the most essential news first, or present some attention-arresting fact or conclusion that will attract and hold the reader's interest. In announcing new scientific or technical discoveries, this first paragraph may be a summary of what is known now that was not known before. But avoid technical or unusual terminology wherever possible.

Bear in mind that a press release is intended for use by the press, radio, or some other medium of news dissemination. It is not achieving its objective when it reaches only the mimeograph machine or an editor's wastebasket. Its ultimate goal is to add to public knowledge.

Remember, too, that it is a common practice of newspaper and magazine editors to cut or pad a story to fit a given space. Put enough information in each paragraph to enable it to stand on its own with what goes before. Don't build up to a climax; it may be chopped off. Don't waste words, not even little ones like prepositions and articles. In journalism, crisp writing is the rule.

Here are a few axioms almost universally accepted among journalists: The objective of a good information service for the public is to get stories printed and distributed where they will be read. A well-prepared press release can be very useful today, but worthless tomorrow, if too late. Timeliness is vital. The importance of any announcement should be clear from the first paragraph. Not all stories will interest all mediums. Nevertheless, they may be offered in the spirit of service. Rarely will a story be used exactly as written. Editors may shorten the release or add supplementary background material taken from the file. Sometimes the release will provide reporters with a starting point for independent research that yields an article in which your contribution may be hard to identify. The best science story for popular consumption is one that shows clearly the value of a scientific study to society.

USEFUL TABLES

Number of words and ems to the square inch

Sizes of type	Number of words		Number of ems	Sizes of type	Number of words		Number of ems
	Solid	Leaded			Solid	Leaded	
14-point	11	8	26½	8-point	32	23	81
12-point	14	11	36	6-point	47	34	144
11-point	17	14	43	5-point	69	50	207
10-point	21	16	52				

Common measures and their metric equivalents

Common measure	Metric equivalent	Common measure	Metric equivalent
Inch	2.54 centimeters.	Dry quart, United States.	1.101 liters.
Foot	0.3048 meter.		
Yard	0.9144 meter.	Quart, imperial	1.136 liters.
Rod	5.029 meters.	Gallon, United States	3.785 liters.
Mile	1.6093 kilometers.	Gallon, imperial	4.544 liters.
Square inch	6.452 square centimeters.	Peck, United States	8.810 liters.
Square foot	0.0929 square meter.	Peck, imperial	9.086 liters.
Square yard	0.836 square meter.	Bushel, United States	35.24 liters.
Square rod	25.29 square meters.	Bushel, imperial	36.35 liters.
Acre	0.4046 hectare.	Ounce, avoirdupois	28.35 grams.
Square mile	259 hectares.	Pound, avoirdupois	0.4536 kilogram.
Cubic inch	16.39 cubic centimeters.	Ton, long	1.0160 metric tons.
Cubic foot	0.0283 cubic meter.	Ton, short	0.9072 metric ton.
Cubic yard	0.7646 cubic meter.	Grain	0.0648 gram.
Cord	3.623 steres.	Ounce, troy	31.103 grams.
Liquid quart, United States.	0.9463 liter.	Pound, troy	0.3732 kilogram.

Signs and symbols frequently used in printing by the Government Printing Office

¶ paragraph
& or ℰ and; ampersand
℔ per
number
/ virgule; solidus; separatrix; shilling
´ acute
` grave
~ tilde
^ circumflex
¯ macron
˘ breve
¨ dieresis; umlaut
¸ cedilla
ˆ caret
+ plus
− minus
± plus or minus
∓ minus or plus
× multiplied by
÷ divided by
= equal to
≠ or ≢ not equal to
≈ or ≒ nearly equal to
≡ identical with
≢ not identical with
≎ equivalent
≏ difference between
≂ or −: difference
≅ congruent with
⊏ or > greater than
≯ or ≩ not greater than
⊐ or < less than
≮ or ≨ not less than
: is to; ratio
:: as; proportion
∺ geometric proportion
≐ approaches
→ approaches limit of, yields
∝ varies as
⊃ is part of
∥ parallel
⊥ perpendicular
∠ angle
∟ right angle
△ triangle
□ square
▭ rectangle
▱ parallelogram
◯ circle
⌒ arc of circle
⊥ equilateral
≦ equiangular
√ radical; root; square root
∛ cube root
∜ fourth root
Σ sum
! or ⌊ product; factorial product
∞ infinity
∫ integral
ƒ function
∂ or δ differential; variation
π pi
∴ therefore
∵ because
— vinculum (above letter)
( ) parentheses
[ ] brackets
{ } braces
° degree
′ minute
″ second
HP horsepower
Δ increment
MΩ megohm
Φ magnetic flux; farad
Ψ dielectric flux; electrostatic flux
ρ resistivity
γ conductivity
Λ equivalent conductivity
ℜ reluctance
→ direction of flow
⇆ electrical current
⬡ benzene ring
⇄ reversible reaction
↓ precipitate
↑ gas
‰ salinity

Greek alphabet

A	α	alpha	I	ι	iota	P	ρ	rho
B	β	beta	K	κ	kappa	Σ	σ ς	sigma
Γ	γ	gamma	Λ	λ	lambda	T	τ	tau
Δ	δ	delta	M	μ	mu	Υ	υ	upsilon
E	ε	epsilon	N	ν	nu	Φ	φ	phi
Z	ζ	zeta	Ξ	ξ	xi	X	χ	chi
H	η	eta	O	ο	omicron	Ψ	ψ	psi
Θ	θ	theta	Π	π	pi	Ω	ω	omega

ESTIMATING NUMBER OF PRINTED PAGES

There are several ways of estimating how many printed pages a manuscript will make. The method followed will depend on the degree of accuracy wanted. Generally, a sampling of the manuscript will enable one to estimate the number of printed pages within 10 percent of the true figure. The data given below can be used to estimate the number of printed pages by using the number of words per manuscript page or the number of square inches per page.

Manuscript pages

Area of "full page" (6 by 8 inches)----------sq in--	48
Lines of double-spaced typing (pica or elite)----------	24
Words per page----------pica--	230
Words per page----------elite--	260
Words per line (averages)----------	10–12

Each text figure may be counted as a page of text.

Printed pages

Area of "full page" (professional papers)----------sq in--	65
Area of "full page" (bulletins, water-supply papers)----------sq in--	31
Lines of leaded 8-point type (abstract, etc.) per inch----------	7
Lines of leaded 10-point type (regular text) per inch----------	6
Words per page of 10-point type (professional papers)----------	1,050
Words per page of 10-point type (bulletins, water-supply papers)----	490

Center headings equal 3 lines of 10-point type, of about ½ inch.

Fifty square inches of manuscript makes approximately 20 square inches of 10-point type.

One hundred full lines of elite typing makes a little more than the same number of 10-point printed lines in a bulletin (or letterpress water-supply paper) and 135 lines in a professional paper.

INDEX

[Words in text printed in boldface type or enclosed in quotation marks are italicized in the index.]

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